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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

International Cooperative Research and Development
between the United States and France, Germany, and
the United Kingdom

By: Orlando R. Aponte,
Edward M. Cavins, and
Georgios Ratsikas
June 2004

Advisors: David F. Matthews,
Raymond E. Franck

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**INTERNATIONAL COOPERATIVE RESEARCH AND DEVELOPMENT BETWEEN
THE UNITED STATES AND FRANCE, GERMANY, AND THE UNITED
KINGDOM**

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MASTER OF BUSINESS ADMINISTRATION

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EXECUTIVE SUMMARY

With defense budgets shrinking throughout the world and coalition forces facing interoperability issues while conducting asymmetric warfare in a post Cold-War environment, many nations are seeking ways to acquire economical weapon systems that are interoperable with allies and coalition members. One method of addressing these concerns is International Cooperative Research and Development (ICR&D). This MBA Project will evaluate the current ICR&D process and make recommendations to enhance the ICR&D process by examining ICR&D between the U.S. and NATO Members, France, Germany, and the United Kingdom. Case studies were used for comparisons in order to determine the advantages and concerns pertaining to ICR&D and to recommend appropriate ICR&D strategies.

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I. INTRODUCTION

A. GENERAL

The fall of the Soviet Union and collapse of the Iron Curtain vastly reduced the probability of a large conventional war between the major powers. Consequently, governments in the North Atlantic Treaty Organization (NATO) used this opportunity to decrease their large defense budgets. The members of NATO, however, still recognized that a threat continues to exist for chemical, biological and nuclear attacks from "rogue" nations. Additionally, the events of September 11th, 2001, reinforced a need to maintain a robust military. The European members of NATO were presented with two military options. One was to maintain a large standing force in order to deter potential enemies. The other called for a smaller force with technologically superior weapons. In order to capitalize on the new "peace dividend" and to address domestic issues, members of NATO have decided to focus on the latter option.

Furthermore, NATO Members could decide to develop these new technologically superior weapon systems either on their own or as part of a partnership with other nations. One method for sharing the burden of weapon-system development is through International Cooperative Research and Development (ICR&D). ICR&D not only shares expenses between participating nations but also shares expertise and technology. The goal of ICR&D is to provide the most economical and advanced weapon systems while sharing risks and technological expertise. ICR&D offers the additional

benefit of minimizing interoperability issues between member nations.

Operations Desert Storm, Enduring Freedom, and Iraqi Freedom all highlighted interoperability issues between coalition members. Weapon systems that are not interoperable can hinder rather than help operations. Given shrinking NATO militaries, interoperability between coalition members will become even more important in future conflicts. Few nations will be able to conduct a war individually. Additionally, many future conflicts will be based upon enforcing the United Nations' resolutions. Naturally, these actions will be multi-national in nature. ICR&D, as previously mentioned, helps to minimize interoperability issues.

This project will address issues and concerns regarding ICR&D efforts between the U.S., Germany, France, and the United Kingdom. For a number of reasons, three ICR&D projects were selected. These were Multiple Launch Rocket System (MLRS), Medium Extended Air Defense System (MEADS), and Joint Strike Fighter (JSF). The lessons learned concerning ICR&D either with a particular nation or in general are presented. If solutions are available, the status and success of each solution is presented. In general, this project synthesizes and presents lessons learned from the selected programs.

B. METHODOLOGY

The documents and news reports regarding each project were gathered using both Internet and library resources. The problems that were confronted, such as the timeliness of material, are highlighted and addressed in the related sections of this project.

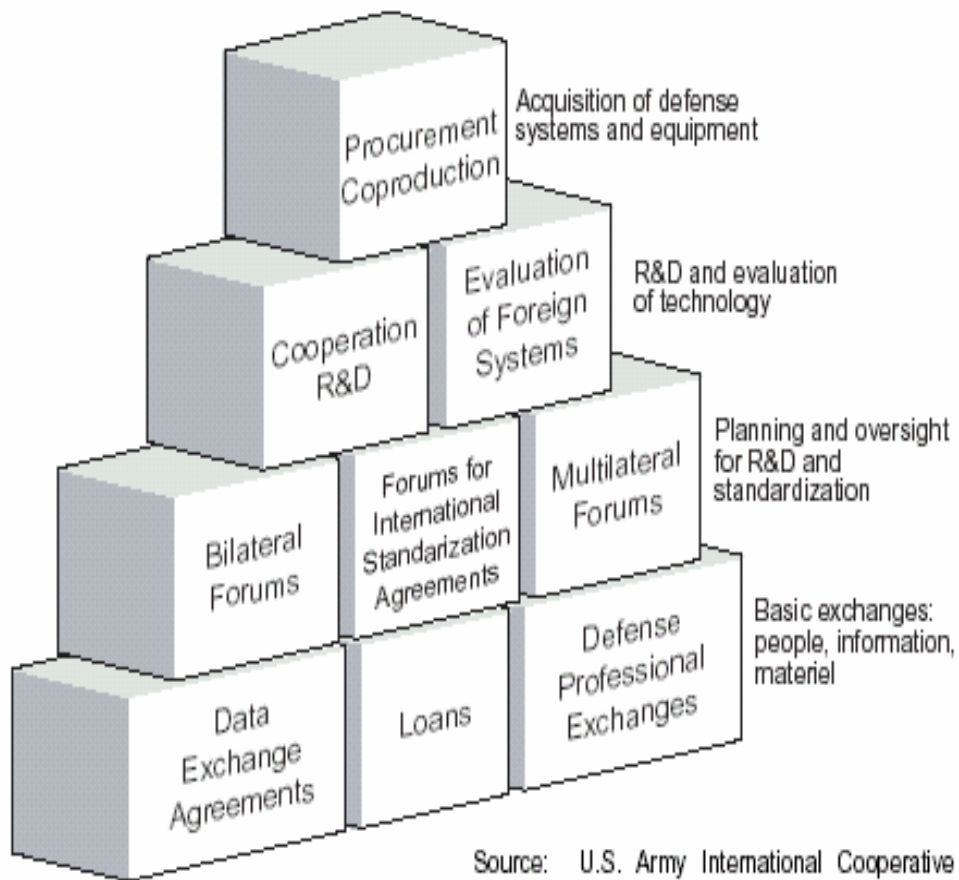
The background of the ICR&D program and related U.S. laws and regulations are presented as well as an industrial-based analysis for Germany, France, the UK, and the U.S. Individual weapon-system programs are then analyzed. The project report then offers conclusions, followed by recommendations. The overall objective of this project is to present information regarding the potential benefits and liabilities of International Cooperative Research and Development (ICR&D) for future weapon-system acquisitions.

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II. BACKGROUND AND LEGAL CONSIDERATIONS

A. FORMS OF INTERNATIONAL COOPERATION

At present, seven areas of cooperation fall under the rubric of International Armaments Cooperation Programs. The range of programs is designed to support U.S. military strategy using the building blocks presented in Figure 1 below.



Source: U.S. Army International Cooperative Program Activity, *The Benefits of International Cooperation*, August 1994 booklet.

Figure 1. International Cooperation Building Blocks

International cooperative research and development refers to:

A program where the DoD and foreign defense ministry, by written agreement, jointly manage a RDT&E and/or production effort to satisfy a common requirement by sharing work, technology, and costs. The purposes of the program are to improve current and future defense posture, enhance the industrial base, avoid duplicate R&D, reduce defense RDT&E costs to each party by sharing information, and improve military system standardization and interoperability of the U.S. and its allies. Since each party contributes manpower, data, and funds to the accomplishment of the common requirement, it is neither necessary nor appropriate to treat the program as a procurement of services or articles by one party from the other. Thus, funds and property may be transferred between the parties for the accomplishment of the project without the need for a contract or an LOA (Letter of Agreement).¹

B. HISTORY AND LEGAL ASPECTS OF THE PROCESS

To a lesser extent, cooperative programs have been in existence since the 1940's. It was not until the 1970's that serious attempts were made at cooperative research and development. During the 1970's, Congress and the Department of Defense recognized a lack of standardization and interoperability with our allies. They also recognized the potential for exploiting the industrial bases of our allies for technology acquisitions and cost savings. Congress and the Department of Defense took steps to promote Rationalization, Standardization, and Interoperability (RSI) with our allies.

¹ United States. Department of Defense. Director of International Cooperation. International Armaments Cooperation Handbook. June 11, 1996, pg 1.

The first attempt to enhance RSI with NATO was the Culver-Nunn amendment to the DoD Authorization Act of 1976. It established that the policy of the U.S. Government was to standardize equipment, or at least have interoperable equipment with NATO allies. It also permitted the purchase of foreign-made equipment to further RSI goals.

Legal authority in Title 10, U.S. Code, confers authority upon the Service Secretaries to conduct and to participate in R&D programs (10 U.S.C. 2358). However, these provisions only authorize R&D programs meeting U.S. military requirements. If the DoD component is to contract on its own and on the other participant's behalf for the cooperative project, obligation authority is created. The authority is limited to funds available in the U.S. Treasury and/or a commercial bank, which holds the foreign partner's funds. Consequently, the Title 10 legal authority is generally used for cooperative research and development programs in which specific tasks are performed by each participant and for which each participant contracts and funds its own share.

In the Quayle Amendment to the International Security and Development Cooperation Act of 1985, the Arms Export Control Act (AECA) was amended. This permitted the U.S. to enter into cooperative research, development and production agreements with NATO allies and permitted a limited authority for DoD to enter contracts outside of the U.S. In 1987, this authorization was extended to include Argentina, Australia, Bahrain, Egypt, Israel, Japan, Jordan, the Republic of Korea, and New Zealand.

In the 1986 Defense Authorization Act, the Nunn-Roth-Warner Amendment created funding for the Office of the

Secretary of Defense for the purpose of cooperative programs and initiated the NATO Cooperative R&D Program. It also authorized cooperative research and development, testing, and evaluation of foreign weapons systems, and the requirement for a Cooperative Opportunities Document. As part of the Amendment, Congress appropriated "Nunn funds." The "Nunn funds" were to be appropriated annually and placed into sub-accounts for each of the Services and OSD to serve as "seed money" for ICR&D programs.

The Cooperative Opportunities Document is used to ensure that opportunities to conduct cooperative research and development projects are considered during an early stage of the research and development review process. The Under Secretary of Defense for Acquisition, Technology, and Logistics prepares one document for each new project for which a Mission Need Statement is developed. In the statement, the Under Secretary must state whether or not the proposed project is similar to any weapon system currently being developed by U.S. allies or whether a current US project can be modified to meet DoD needs. The Under Secretary must also discuss the advantages and disadvantages of the proposed project with respect to program timing, developmental and life cycle costs, technology sharing, and RSI. The Under Secretary concludes with a recommendation concerning the feasibility and desirability of a cooperative research and development program.

In June 1993, Deputy Secretary of Defense William J. Perry established the Armaments Cooperation Steering Committee (ACSC). This committee is composed of the Under Secretary of Defense (Acquisition, Technology, &

Logistics), Under Secretary of Defense (Policy), Vice Chairman of the Joint Chiefs of Staff, and senior representatives from each Service. The ACSC was established to maintain continual oversight of DoD's armaments cooperative activities and to ensure these activities receive the proper visibility and conform to U.S. national security policy.

In a memorandum dated 23 March 1997, Secretary of Defense William S. Cohen identified cooperative research and development as "the Department of Defense Bridge to the 21st Century." He went on to state the U.S. military must achieve at a minimum:

Deployment and support of standardized, or at least interoperable, equipment with our potential coalition partners and leverage of U.S. resources through cost sharing and economies of scale afforded by international cooperative research, development, production and logistic support programs.²

In order to obtain the objectives above, he directed that:

We engage Allies in discussions at the earliest practicable stages to identify common mission problems, and to arrive jointly at acceptable mission performance requirements, balancing cost as an independent variable (affordability), meeting coalition military capability needs, and assuring interoperability. The USD (AT&L), in coordination with the USD (P) and with the recommendation of affected DoD Component, will designate appropriate defense acquisition programs as international cooperative programs. The DoD must be a reliable international partner by funding fully the U.S. share of such programs. Should circumstances arise which necessitate less than full funding for a designated international

² Cohen, William S. Memorandum. "DOD International Armaments Cooperation Policy." 23 March 1997.

cooperative program, the Component Acquisition Executive shall notify the USD (AT&L), at the earliest opportunity, of the Component's intent to terminate or substantially reduce funding for the program.³

Secretary of Defense Cohen further reinforces the use of ICR&D by placing IRC&D in the 1997 Report of the Quadrennial Defense Review (QDR). In the 1997 QDR, he states,

We as a nation must often act in concert with others to create our preferred international conditions and secure our basic goals ... Therefore, it is imperative that the United States strives to build close, cooperative relations with the world's most influential. To maintain this superiority, we must achieve a new level of proficiency in our ability to conduct joint and combined operations. The Revolution in Business Affairs includes ... increasing cooperative development programs with allies.⁴

Secretary of Defense Cohen recognized that decreasing military budgets had steadily declined Government research and development expenditures relative to industry (Figure 2). In an effort to combat this trend, the Navy attempted to increase the ICR&D efforts in the 1990's in order to share the cost burdens associated with research and development (Figure 3).

³ Cohen, William S. Memorandum. "DOD International Armaments Cooperation Policy." 23 March 1997.

⁴ Cohen, William S. "1997 Report of the Quadrennial Defense Review." Report retrieved 12 February 2004 from website <http://www.defenselink.mil/pubs/qdr/sec3.html>.

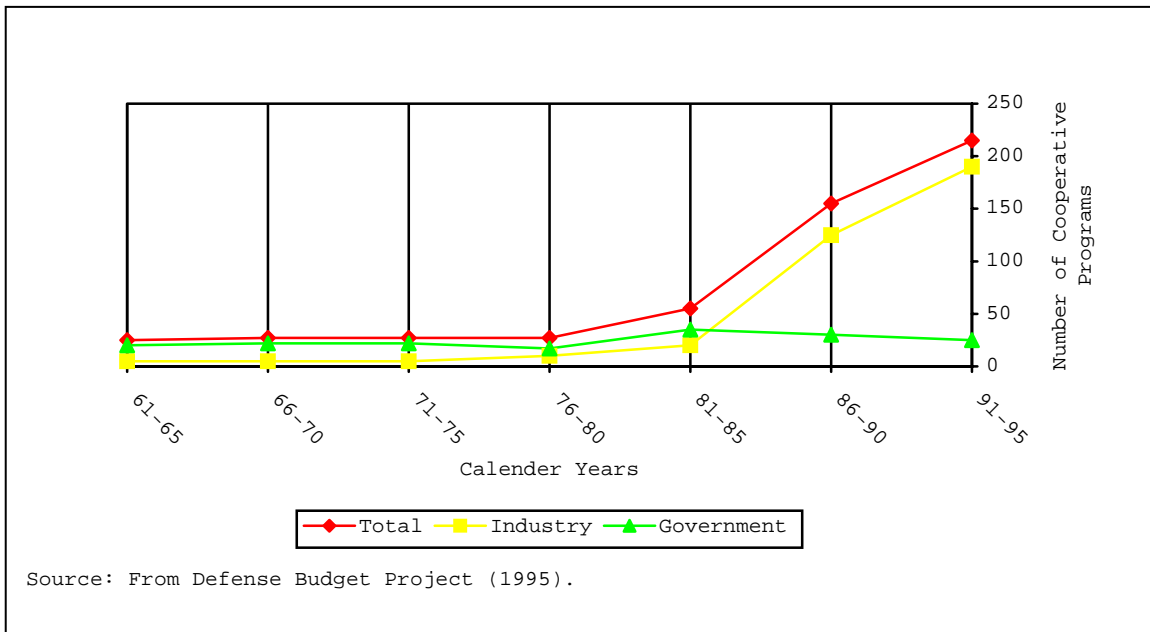


Figure 2. Growth in Industry-Led International Cooperation

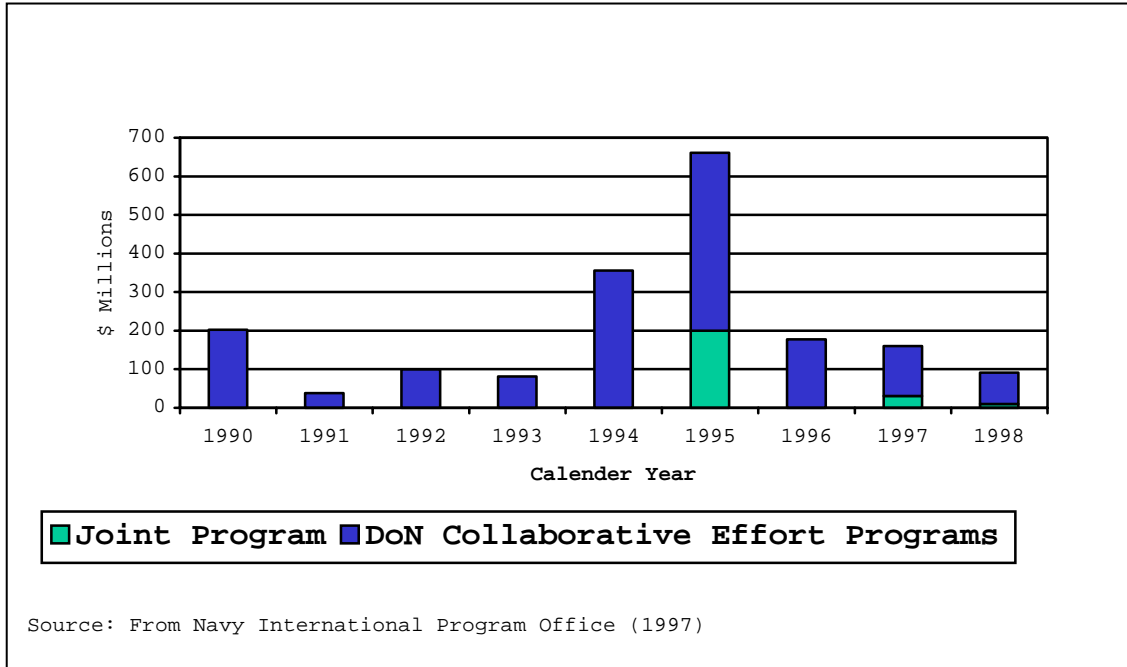


Figure 3. Cooperative Programs/MOU Foreign Contributions

Cooperative research and development programs are conducted under the terms of some types of international agreements. International agreements are either treaties or executive agreements under DoD Directive 5530.3. Treaties are international agreements approved by a two-thirds vote in the Senate and covered under Article II, Section 2 of the U.S. Constitution. Executive agreements are entered into by an authorized member of the executive branch and are based upon legal authority. Executive agreements come in the form of a memorandum of understanding (MOU), memorandum of agreement (MOA), memorandum of arrangements, exchange of notes, exchange of letters, technical arrangement, protocol, note verbal, aide memoire, statement of intent, letter of intent, or statement of understanding. Contracts made under the Federal Acquisition Regulation (FAR), Foreign Military Sales (FMS) Letters of Agreement, FMS Letters of Instruction, standardization agreements, and leases are not considered international agreements.

C. MEMORANDUMS OF UNDERSTANDING

MOU's are generally the most common collaborative agreements for ICR&D. The typical timeframe for MOU's, from first draft to final signature, is roughly two years. In order to ensure a smooth process, each country identifies a program representative. These representatives form a steering committee to facilitate the process. Normally, technical discussions occur prior to the formal negotiation process.

Several key aspects of the program are identified and addressed in the MOU. They are the basic structure, management structure, finance, contracting, information disclosure, and third party sales.

The basic structure of the MOU addresses the timeframe and phase applicability of the MOU. For instance, the MOU can be a stand-alone for a particular phase of the program or can be a Program MOU (PMOU). A PMOU provides a standard framework for the entire life of the program and contains supplements for each program phase. In a PMOU, negotiations only occur prior to each new phase. This minimizes drafting time for the original MOU and permits greater flexibility.

Management structure identifies the voting procedures/rights and number of program representatives for each participating nation. Configuration management is addressed here. Since one of the objectives is interoperability, the steering committee sets acceptable interoperability levels.

The finance portion addresses the currency to be used for payments, the frequency of payments, and cost shares. Payment considerations and changing exchange rates can have serious implications for time delays and schedule risk. The cost share will define each participating nation's cooperative status and privileges. Cost sharing is further addressed later in this chapter.

Contracting refers to addressing the current methods of contracting and the contracting vehicles to be used. Most international partners are unaware of the most current U.S. contracting methods and procedures due to recent DoD acquisition reforms. This familiarizes them with the most

up-to-date procedures. Additionally, discussions occur in order to determine the most effective contracting vehicle for each phase or country.

Information disclosure gained during the program is normally tied to cost sharing ratios. The standard levels of information transfer for each cost-share level will be further addressed later in this chapter. The information disclosure in the MOU also discusses contractor intellectual property rights. Frequently, background information is available for all participants in the program with the stipulation that the information is not releasable outside of the program.

The third-party sales portion of the MOU addresses which countries can sell or buy the weapon system in the future. In this section great care is taken, to protect intellectual property rights and the national interests of participating contractors and nations.

D. LEVELS OF PARTNERSHIPS

Upon entering into an international agreement for cooperative research and development, funding contributions determine the country's category and its associated rights in the program. The four categories are full collaborative partner, associate partner, informed partner, and Foreign Military Sales major participant.

Full collaborative partners provide at least ten percent of the target research and development funding. The country participates in the requirements development, has positions at the Program Office, and a National Deputy at the Director Level. The country also receives a waiver for all non-recurring research and development costs.

Associate partners contribute at least five percent of the target research and development funding. The country may influence requirements as long as the U.S. perceives the results to be mutually beneficial. The country also has a few positions in the program office and receives a waiver for non-recurring research and development costs.

Informed partners provide one to two percent of the target research and development funding. Foreign Military Sales major participants contribute less than one percent. Informed partners and FMS major participants have little influence on requirements generation and minimal representation in the program office. Their main attraction is priority order status, such as that received by full collaborative partners and associate partners.

Upon completion of cooperative research and development, countries can either contribute funding for the Production Demonstration and Deployment Phase or drop out of the program. Furthermore, the countries are permitted to increase or lower their contribution levels. The levels of contribution place the countries into categories similar to the research and development phase. The categories are Level I, Level II, and Level III. These levels are similar to full collaborative partner, associate partner and informed partner.

E. CURRENT TRENDS

International cooperative research and development has started to become more of the norm rather than the exception for weapons systems. The previously discussed legislation has forced DoD to participate with international military forces actively. These initiatives

have occurred for good reasons. The International Armaments Cooperation Handbook states,

As U.S. armed forces and those of its allies and friends are drawn down, budgets reduced, coalition operations increased, and the defense industrial base is consolidated and restructured, we must examine every opportunity to increase effectiveness and efficiency of the armed forces and industries of the U.S. and its allies and friends. International armaments cooperation is a primary means to achieve those goals.⁵

The handbook goes on further to identify the objectives of cooperation as:

- 1) The deployment and support of common, or at least interoperable, equipment with U.S. friends and allies.
- 2) Achieving cost savings through cost sharing and economies of scale in jointly managed Research and Development (R&D), production, and logistics support programs.
- 3) Exploiting the best technologies, military or civilian, available for equipping the U.S., its allies, and other friendly countries.
- 4) Supplying the best available defense material to the U.S., its allies, and other friendly countries in the most timely and cost-effective manner.
- 5) Maintaining a strong U.S. and allied industrial base.⁶

⁵ United States. Department of Defense. Director of International Cooperation. International Armaments Cooperation Handbook. June 11, 1996, pg 1.

⁶ Ibid, pgs 2-3.

III. DEFENSE INDUSTRIAL BASE CONSIDERATIONS

A. EUROPE IN GENERAL

In the past, and more recently, pressure to develop a unified European armament procurement policy and related industrial base has been increasing, as most nations can no longer afford to develop and to procure defense items solely from their own domestic companies and sources. Consequently, European nations are currently pursuing several initiatives to integrate their defense markets. They remain committed to cooperative programs, which are at the core of cross-border defense cooperation at the industry level. However, national sovereignty issues and complex ownership structures may prevent European consolidation to the extent needed to be competitive. This also holds true for cooperative programs between the United States and the European nations in the defense industrial base arena.

Similarly to the United States, European countries generally purchase major defense equipment from domestic companies whenever possible. When domestic options do not exist, key European countries vary in their intent to buy major U.S. weapon systems. Additionally, the United States cannot hope to export major defense items to Europe without involving European defense companies in the production of those items. Several U.S. defense companies are currently nurturing long-term partnerships with European companies to develop a defense product line that will meet the requirements in both the U.S. and Europe. Among the factors contributing to this trend are affordability (related to reduced defense budgets), and interoperability

(related to the need to operate within coalitions in the new world geopolitical situation). For instance, defense spending as a percentage of GDP in Europe has dropped from 3.5 percent at the height of the Cold War in the late 1980s, to about two percent today, barely enough to sustain current forces.⁷ By contrast, U.S. defense budgets have grown nearly ten percent a year for the past three years due to the threat-driven quest for leaner and meaner armed forces. While the U.S. devotes 24 percent of its budget to R&D and 34 percent to personnel, Europe spends 15 percent and 61 percent, respectively. Much of Europe's procurement is committed to long-term legacy projects such as the Eurofighter. Furthermore, the United States spends more on defense than all of the members of NATO, combined, as seen in Figure 1.⁸

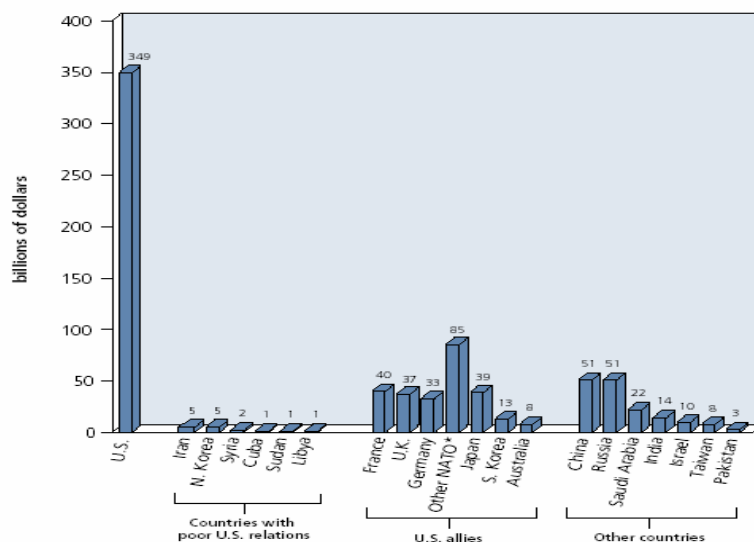


Figure 4. Global Military Spending Comparisons, 2002

⁷ Valasek, Tomas. "No Will, No Way on European Defense." Wall Street Journal Europe. 02 October 2003.

⁸ "Vital Statistics: The U.S. Military." The Defense Monitor, Center for Defense Information. Volume XXXII, Number 5, November/December 2003.

The formation of a more unified European defense market may be crucial to the survival of European defense industries as well as to their country's ability to maintain an independent foreign and security policy. Individual national markets are too small to support an efficient industry. Meanwhile, mergers and consolidations of U.S. defense companies pose a challenge to the smaller, fragmented European defense industry. To respond, European governments have used a variety of organizations such as the Western European Union (WEU), the European Union (EU), and the North Atlantic Treaty Organization (NATO). Most recently, the EU and NATO have become the preferred organizations to address economic and armament policy issues. NATO Membership applications from former Warsaw Pact countries have increased significantly in recent years.

The European Defense Industry is attempting to consolidate and restructure through national and cross-border mergers, acquisitions, joint ventures, and consortia. In 1997, the United States General Accounting Office (GAO) reported to the Secretary of Defense that:

European government and industry observers have noted that the European defense industry is reacting to pressures from rapid U.S. defense industry consolidation, tighter defense budgets, and stronger competition in the global defense market. Even under these pressures, other observers have noted that European defense companies are consolidating at a slower pace than U.S. defense companies.⁹

⁹ United States. General Accounting Office. European Initiatives to Integrate the Defense Market. GAO/NSIAD-98-6. October 1997.

The GAO Report also noted that while economic pressures to consolidate exist, according to European government and industry officials, European defense companies face several obstacles. National governments impede defense industrial integration by establishing different defense equipment requirements. National governments also frequently regard their defense companies as sovereign assets. They tend, therefore, to impede cross-border consolidation because it could reduce the national defense industrial base or make it too specialized. Furthermore, complex ownership structures make cross-border mergers difficult since many of the larger European defense companies are state-owned or part of larger conglomerates.

To varying degrees, defense industry restructuring has occurred within the borders of major European defense material-producing nations, including France, Germany, Italy, and the United Kingdom. In the late 1990's, several mergers occurred in prominent European nations with large defense industrial bases. For example, in Italy, Finmeccanica had control of about three-quarters of the Italian defense industry, including Agusta (the major helicopter manufacturer) and Alenia (the major aircraft manufacturer).¹⁰

European countries have long partnered on cooperative armament programs to develop and to produce large weapon systems in Europe. The trend is to create a central management company to manage the relationship between partners. For instance, the Eurofighter 2000 program

¹⁰ United States. General Accounting Office. European Initiatives to Integrate the Defense Market. GAO/NSIAD-98-6. October 1997.

created a consortium among major aerospace companies from the United Kingdom (British Aerospace), Germany (Daimler-Benz Aerospace), Italy (Alenia), and Spain (CASA). The same happened with the Joint Strike Fighter (JSF), with the United States taking the lead role. So, to some extent, the U.S. has recently been more actively partnering on cooperative armament programs. Although most cross-border industry cooperation is project-specific, European defense companies are also acquiring companies or establishing joint ventures or cross-share holdings that are not tied to a particular program, as has occurred in missiles, defense electronics, and space systems.

Still, individual European governments, including France, Germany, Italy, the Netherlands, and the United Kingdom, try to retain their own defense procurement policies. These countries also vary in their willingness to purchase and to collaborate on major U.S. weapons systems. Furthermore, Europe has a large, diverse defense industrial base upon which key European countries rely for purchases of major defense systems and equipment, especially from their own national sources.

As European nations move toward greater armament cooperation, the U.S. Government and defense industry have taken steps to improve transatlantic cooperation. The U.S. Government continuously seeks opportunities to form transatlantic partnerships with its European allies on defense equipment research, development, and production. The U.S. defense companies are forming industrial partnerships and have emphasized ICR&D efforts with European companies to sell defense equipment to Europe because of the need to increase international sales,

maintain market access, preserve the domestic industrial base, and lower unit procurement costs on sophisticated weapons systems. As a matter of survival for both U.S. and European defense industrial bases (due to declining defense budgets after the Cold War), ICR&D has emerged as a way to maintain military technological superiority on both sides of the Atlantic Ocean while satisfying national economical and industrial goals.

The Department of Defense realized that the U.S. could take advantage of international armaments cooperation to leverage U.S. resources through cost-sharing and improving standardization and interoperability of defense equipment with potential coalition partners. Furthermore, aside from the Ballistic Missile Defense Program, the F-35 Joint Strike Fighter Program (an international cooperative program) is the largest U.S. Weapons Program currently underway, as depicted in Table 1.¹¹

¹¹ Sources: "Vital Statistics: The U.S. Military." The Defense Monitor, Center for Defense Information, Volume XXXII, Number 5, November/December 2003. "Selected Acquisition Report." United States Department of Defense, December 31, 2002. The Full Costs of Ballistic Missile Defense, Economists Allied for Arms Reduction and Center for Arms Control and Non-Proliferation, January 2003.

WEAPON	TYPE	COST*	QTY
Ballistic Missile Defense	Missile Defense	744.0	-
F-35 Joint Strike Fighter	Fighter-Bomber	163.6	2,457
SSN-774 Virginia class	Attack Submarine	74.1	30
F-22 Raptor	Fighter-Bomber	73.3	278
DDG-51 Arleigh Burke class	Guided Missile Destroyer	68.8	62
C-17 Globemaster III	Transport Plane	65.1	180
F/A-18E/F Super Hornet	Fighter-Bomber	50.0	552
V-22 Osprey	Transport Aircraft	46.6	458
Trident II	Nuclear Missile	42.5	568
RAH-66 Comanche	Helicopter	34.6	650

* Total Cost in billions of constant 2003 dollars

Table 1. Ten Largest U.S. Weapons Program

B. FRANCE

The U.S. and France share many trade similarities, including their global standing as the top two exporters in the defense sector. Overall, France is the tenth-largest trading partner of the United States worldwide and the third largest in Europe, after the United Kingdom and Germany.

1. Defense Procurement Policy

The French defense procurement policy primarily aims at buying technically sophisticated equipment from French sources, then pursuing European cooperative solutions, and finally importing a non-European item. Recently, the policy has shifted to having European cooperative programs as the first alternative due to the costs of developing major systems alone. However, the French procurement policy still attempts to retain its defense industrial base and to maintain autonomy in national security matters.

France has generally purchased major U.S. defense weapon systems only when no French or European option is available.

The French defense policy must be analyzed within the new strategic context: disappearance of major threats close to French borders and the gradual restructuring of Europe. With respect to the latter, France intends to participate in the restructuring and renovation of NATO as a way to provide Europe with the means and assets it needs to achieve European capabilities.

France has sought to remain a leading military power by acquiring a small-scale version of a superpower arsenal with an independent nuclear deterrent, a conventional force for air and land combat, and a Rapid Action Force and Blue Water Navy for intervening in overseas crises of limited scope and duration. Consequently, France is giving first priority to developing and maintaining its strategic nuclear capability, maintaining an autonomous defense-industrial base capable of furnishing the full range of material required by the French Armed Forces, and procuring military systems at affordable cost.

2. Defense Industrial Base

The multi-billion dollar defense market in France is experiencing profound changes similar to those in the U.S. By any measure, the French defense market is large, varied, and sophisticated. France produces nearly 90 percent of its own armament requirements. The defense industry serves a large indigenous force and exports to over 25 countries. A clearly defined strategy of forging stronger European alliances through increased mergers and acquisitions

pervades the current rationalization of France's defense industrial base.

The goal of national autonomy in defense procurement has resulted in the acquisition of nearly all French weapons from domestic sources or joint ventures involving French companies, even when superior or less expensive alternatives were available from abroad. Due to the size of the French domestic arms market, concentration at the prime-contractor level has led to a group of sole-source "national champion" firms that are the national repositories of design and manufacturing know-how for entire sectors of defense equipment. The French defense industry also relies heavily on export sales to amortize overhead costs and permit the economic production of weapons for France's own use. While intra-European cooperation is not new, France's change in that direction indicates that it no longer intends to develop a wide range of weapon programs on their own.

Since the late 1980's, however, a convergence of economic, political, and military factors is forcing a major restructuring of French military forces and the defense industrial base that supports them. Weapons acquisition programs and arms exports are the responsibility of the General Delegation for Armaments (DGA), a centralized procurement agency within the Ministry of Defense. In addition to supplying the armed forces and safeguarding the autonomy of the national defense industry, the DGA adapts the industry to France's overall industrial needs and negotiates collaborative weapon development and production programs with other countries. DGA officials believe that in the state-dominated defense field,

administrative controls on quality and cost are superior to relying on market mechanisms such as competition. But a drawback of the French procurement system is that decisions tend to be made in a secretive, top-down manner, with limited accountability to either Parliament or the public.

France's concern for national security and defense independence led to the nationalization of the French defense industry, as well as its demise. In recent years, decreased defense budgets have resulted in a weakened domestic defense industry. The needs of France's large defense industrial base exceeded those of the French military. Consequently, France became a major arms exporter with a questionable reputation. Recent reductions in export sales, however, have negatively impacted the once-powerful stand-alone French defense industrial base.

Currently, the French defense industry is restructuring in response to budget cuts, shrinking export sales, and rapid technological advances, many of them driven by commercial applications. In an effort to manage the transition and to mitigate its adverse effects upon employment and regional economies, the DGA is pursuing an active defense-industrial policy focused around two pillars. The first is preserving and promoting the technological competencies of the defense industry by converting national arsenals into state-owned companies, encouraging defense contractors to diversify into the civil sector, investing in defense R&D at the expense of current production, urging firms to concentrate on areas of excellence to improve their competitive advantage, and promoting greater reliance on dual-use technologies. The second is enabling French defense firms to play a leading

role in the restructuring of defense production on the European scale, through collaborative research and development programs, strategic alliances, acquisitions of foreign firms, and cross-border mergers. France could not remain an exception to the different and varying degrees and extents of defense industry restructuring that has occurred within the borders of major European defense producing nations. In France, for instance, Thomson CSF and Aerospatiale formed a company, Sextant Avionique, which regrouped and merged their avionics and flight electronics activities.¹²

For the purpose of ICR&D, France and the U.S.'s defense industries share some basic similarities. However, there are significant differences. First, whereas the U.S. defense industry is mainly in private hands and the U.S. Government emphasizes market mechanisms, nearly four-fifths of the French defense industry is controlled by the state and broadly managed by the government. Second, the French Parliament has much less power over defense decisions than does the U.S. Congress.

France has had some success in diversifying its defense industry into commercial markets, promoting the integration of civil and military production, and pursuing strategic alliances and other forms of international collaboration in defense R&D and procurement. However, over-reliance on profits from arms exports to subsidize defense research and development has created pressures to sell arms under circumstances that have adversely affected French foreign policy. Shrinking export markets in recent

¹² United States. General Accounting Office. European Initiatives to Integrate the Defense Market. GAO/NSIAD-98-6. October 1997.

years have also reduced the ability of French defense contractors to remain at the technological leading edge.

Overall, France has managed defense R&D and procurement to preserve a broad-based defense industry for the future, but at some cost to its current military capabilities. In contrast, the United States has managed defense R&D and procurement to maximize its current military capability, but at some cost to the future health of their defense-industrial base.

3. Defense Opportunities

France is continuing to update its major defense equipment, including submarines, aircraft carriers, helicopters, tanks, and aircraft. Program priorities include intelligence gathering, command and control systems, troop protection, force mobility, and military transport. France is currently a participant in multilateral ship propulsion (ICR) and datalink (MIDS) cooperative efforts. Industry-to-industry cooperation is clearly on the rise as U.S. firms seek opportunities to win European defense competitions through partnerships with European firms. For example, Bath Iron Works and the French shipbuilding organization, Direction de la Construction Navale Internationale (DCNI), are cooperating to build ships for the international market. France targets over 40 projects for multinational cooperative development.

4. Defense Procurement Process

The Direction Generale de l'Armement (DGA), or General Delegation for Armaments, is the official body responsible for all armament programs for the three defense services and the national police. It controls all research,

development, and production in collaboration with the Joint Chiefs of Staff and the three service Chiefs of Staff. As the Ministry of Defense directorate is solely responsible for weapons system acquisition, the DGA monitors the private and nationalized firms involved in armaments research and production, and retains tight control over all phases of the acquisition process. It also does all of its own research and development (R&D) for the military services. The acquisition process in France is characterized by centralization and a structure of coordination and interaction among the various MOD Directorates. Although the responsibility for weapon systems acquisition is centralized within the DGA, each of the directorates plays a role throughout the acquisition process.

C. GERMANY

Although Germany does not seek to become self sufficient in defense production or have firms solely reliant upon arms contracts, domestic firms receive approximately 85 percent of defense spending, which includes research and development, procurement, and maintenance. Virtually all defense contractors in Germany are privately owned, but many have stock owned by federal states or banks. Competition is allowed for contracts at all stages, from program definition to final production.

1. Defense Procurement Policy

Germany, to some extent, shares the UK's and France's defense procurement policy while providing a unique mix of both: to have open competition on most major defense equipment purchases, with a commitment to European

cooperative solutions. This results from significantly reduced defense procurement budgets and existing commitments to European cooperative projects.

2. Defense Industrial Base

Germany could not remain an exception to the different and varying degrees and extents of defense industry restructuring that has occurred within the borders of major European defense-producing nations. In Germany, restructuring has primarily occurred in the aerospace sector. In 1995, Deutsche Aerospace became Daimler-Benz Aerospace, which includes about 80 percent of German industrial capabilities in aerospace. In 1999, the German firm Daimler-Chrysler Aerospace and the French Aerospatiale Matra made a major cross-border merger with the subsequent inclusion of the Spanish aerospace company Construcciones Aeronauticas S.A. (CASA).

With regard to industry structure, the German industrial giant Daimler-Benz acquired the aircraft manufacturer MBB. This action became the focal point of restructuring the German defense industry, which is one of the most technologically advanced in the world. Daimler-Benz has also incorporated the aircraft firm Dornier, engine manufacturer MTU, and the electronics firm AEG. Daimler Benz Aerospace (commonly referred to as DASA), a group within Daimler-Benz, has combined the proficiency of Dornier, Motoren und Turbinen-Union (MTU), Telefunken Systemtechnik (TST), and MBB. These acquisitions have made Daimler-Benz the seventh largest defense firm in the world, and the third largest in Europe.

Analysts expect the German defense industry to undergo further concentration in an effort to reduce overcapacity.

Consolidations and mergers of German and European firms will generally not achieve the same efficiency as those of U.S. firms. Recognizing the difficulties inherent in multinational mergers, top officials of Daimler-Benz Aerospace now appear to favor a national consolidation of Germany's defense industry before looking for structural alliances abroad. This is a turnaround from their previous position.¹³

Germany has traditionally used Foreign Military Sales (FMS) channels when purchasing systems from the U.S. Cooperative programs are also gaining increased emphasis and interest. With a goal of reducing costs and obtaining the best technology available, the U.S. Department of Defense has initiated discussions to facilitate longer-range bi- and multi-lateral planning, with a goal of increased harmonization of future requirements that could lead to more cooperative programs.

Unlike the United States and the United Kingdom, Germany's corporate governance structure within the defense industry is continental, which also differentiates its defense industries when establishing ICR&D programs. German public-limited companies still remain tied to industrial investment that acts as a stable ownership mechanism; hence industry owners play a large role in the German ownership scheme. This highlights the strategic importance of concentrated ownership by industry and government figures in the defense industrial base. Ownership concentration has proven decisive in maintaining

¹³ United States. Department of Commerce. Bureau of Industry and Security. "European Diversification and Defense Market Guide." Reported retrieved 10 March 2004 from website <http://www.bxa.doc.gov/DefenseIndustrialBasePrograms/>.

stability in continental European defense companies and, on the other hand, the lack of such concentration has provided flexibility in the British-American firms.

3. Defense Opportunities

The sophisticated German market offers a wide variety of defense opportunities in the areas of equipment upgrades and new equipment. The combination of budget restraints and the limits imposed by export laws, is putting pressure on German firms to find cost-sharing partners for both research and development and production of defense merchandise. U.S. firms can profit, even in the current restrictive German spending environment, by joining with German firms in efforts to fulfill defense requirements.

The unification of Germany included the merging of the two armed forces and their inventories. Most of the East German equipment was supplied by the Soviet Union. The German government is retaining some of this inventory. The platforms intended to be kept as interim systems include the MIG-29 fighter, the AN-2, IL-62, L-410, and TU-154 transport aircraft, and the MI-2, MI-8, and MI-14 helicopters.

4. Defense Procurement Process

Within Germany, the Services create the requirements and submit them to the Armaments Directorate of the Ministry of Defense to approve and prioritize the requirements within a national plan. If required, parliamentary approval is obtained and finally, the requirements are turned over to the Federal Office of Defense Technology and Procurement (Bundesamt für Wehrtechnik und Beschaffung, or BWB), which will fill the Services' requirements. While this is a somewhat

simplified description, it clarifies the key difference from the U.S. system, where the Services are heavily involved throughout the entire acquisition process.

While procedures vary depending upon the nature of the award, government tendering in Germany is generally open to all qualified suppliers on a competitive, non-discriminatory basis. This means that, with few exceptions, German government purchasing entities are required to award contracts based upon objective criteria that, at least in theory, neither directly nor indirectly favor domestic German companies over foreign suppliers. Technology transfer does not seem to be obstructed by official impediments or other barriers.

D. UNITED KINGDOM (UK)

Political stability, low rates of direct taxation, assured intellectual property rights, a flexible labor market, first-class financial markets, and membership in the European Union (EU) make the UK an especially attractive market for U.S. exporters and investors. Market entry for U.S. firms is greatly facilitated by a common language and legal environment, and similar business institutions and practices.

1. Defense Procurement Policy

The UK fosters open competition policies that seek the best defense equipment for the best value. As such, the UK's defense procurement policy seeks best value for money, which usually means taking a commercial approach to procurement by using competition. Competition is the cornerstone of the Ministry of Defense (MOD) policy. In accordance with its open competition policy, the MOD will acquire defense equipment from foreign sources when the

advantages of cost, performance, and delivery schedule outweigh the benefits of buying the British alternative. This policy further enhances the United States-United Kingdom approach toward ICR&D. The United States is the major supplier of defense imports to the UK. The main factors contributing to the U.S. success are the uniqueness and technical sophistication of the U.S. defense systems, industrial participation offered to local U.S. companies, and/or no domestically developed product in the competition. However, the UK Government tends to choose a domestically-developed product when one exists. In some cases, these products contain significant U.S. content.

Despite severe budgetary pressures, the UK Government does not have a formal policy to protect its core defense industrial base. The MOD's "Best Value for Money" procurement policy has forced UK defense companies to rationalize the industrial base in order to remain internationally competitive. Increased emphasis on UK "Industrial Participation" in contracts awarded to offshore firms is used to bolster strategic economic sectors and to maintain quality jobs.

The United Kingdom simply could not remain an exception to the different degrees of defense industry restructuring that has occurred within the borders of other major European defense-producing nations. In the UK, a number of mergers and acquisitions have occurred. For example, GKN purchased the helicopter manufacturer Westland and GEC purchased the military vehicle and shipbuilder VSEL in 1994. In 1999, British Aerospace merged with General Electric's Marconi division.

2. Defense Industrial Base

The UK defense budget represents about 3.5 percent of GDP. The defense industry is largely privatized and is dominated by three large contractors (British Aerospace, GEC-Marconi, and GKN) and a second tier of smaller, more specialized companies. The British defense industry is similar to the United States since both are products of a market-based system. The UK, with well-developed capital markets, relies on equity investments and less on large institutional creditors providing greater flexibility and adaptability when dealing with ICR&D among international partners, especially the United States. Recent reports note that the Department of Defense is more comfortable dealing with foreign firms that are similar to American companies, as is the case with the UK firms.

3. Defense Opportunities

The major areas with opportunities for defense equipment sales are aircraft and related parts, electronics production and test equipment, electronic components, airport and ground support equipment, lasers and electro-optics, and telecommunications equipment. Future upgrade opportunities, including service, support, and logistics, are found in cruise missile systems, parts for fixed-wing aircraft and helicopter maintenance, and aircraft replacement programs, and mission systems integration technology for various major equipment procurement programs (as prime contractor or subcontractor).

4. Defense Procurement Process

The NATO nations have Memorandums of Understanding (MOU's) that apply to procuring defense equipment. These agreements promise that each government will look at its

partner's military equipment first. Of all U.S. allies, the UK enjoys the closest operational relationship with U.S. forces. As a result, the UK has procured American, or U.S.-compatible defense equipment, a number of times.

UK defense acquisition programs are driven by operational requirements, much as in the United States. The Central Staff (land, sea, air, and joint systems) is responsible for defining these requirements. Once approved for acquisition, the MOD's procurement executive acts as the main executive agent for program competition in the UK.

The MOD's acquisition policy employs competitive "firm fixed price" contracting, wherever possible, and the MOD will rarely fund development costs for a program. The majority of its requirements are focused on "off-the-shelf" purchases, often requiring contractor development. The MOD's policy is to amortize this cost over the production run of the system.

E. UNITED STATES OF AMERICA

A strong defense industrial base deters aggression, and provides the means to wage war and to defeat enemies, if deterrence fails. The National Security Strategy of the United States specifies that the defense policy since the end of World War II has been aimed at deterring aggression against both the United States and its allies. This deterrence policy is the military strategy against both conventional and nuclear aggression.

Some analysts believe that the current industrial base seems incapable of surging production rates in a timely

fashion.¹⁴ Industrial-base surge has been a concern for some time. A number of factors have contributed to this situation. Military weapons have become so dependent upon technology that large quantities are not only difficult to produce in a short period, but expeditious startup and production are more difficult. Long lead-time contracts and increased dependence upon foreign sources for supplies and materials have also reduced the potential for rapid expansion of defense production.

The U.S. industrial base, although large and technologically diverse, is highly dependent upon foreign sources of supply for many critical materials, components, and end items. Thus, the U.S. and Europe —challenged to meet industrial preparedness demands independently—recognize that enhanced integration of their defense industrial bases could take advantage of the complementary nature of their defense industries to provide both increased security and economic gain.¹⁵

1. Defense Procurement Policy

The United States promotes full and open competition policies that seek the best defense equipment for the best value. As such, the U.S. procurement policy is to aim for the best value at the lowest cost, which means taking a commercial approach to competitive procurement. The U.S. also emphasizes establishing a strong defense industrial base and procurement from its own national sources, hence the Buy American Act. The U.S. defense industry is highly

¹⁴ McNichols, Jeffrey R. The Visible Hand: The Government-Industrial Relationship and Its Effects on Transatlantic Arms Cooperation. Thesis. Naval Postgraduate School. June 2000.

¹⁵ Ibid.

competitive. Although the industry has consolidated in past years, competition still remains a key element of the industry. The structure of the defense industry is largely driven by the defense policy of the U.S. Government and its rules that govern the sales of defense systems and equipment. Export controls by the U.S. Government tend to limit and to complicate the sale of defense items worldwide. At the same time, controls are necessary to provide protection against loss of technology to unauthorized users. Export controls impact the defense trade of the U.S. with its European counterparts due to the issues concerning intellectual property and the transfer of technology.

2. Defense Industrial Base

Within the defense industrial base three categories of firms produce supplies and equipment for the DoD. First, the government owns and operates some facilities. These facilities produce products that are somewhat specialized and for which there is no commercial application. A Government-Owned and Contractor-Operated (GOCO) facility represents a second category of supplier. There are relatively few Government-Owned firms, however, as current policy dictates that a minimum number of facilities be Government-Owned. The third category, the largest supplier to the DoD, consists of contractor-owned and operated facilities.

The U.S. defense industry is more diverse (in terms of the number of companies) than their European counterparts. The overall U.S. Defense Industrial Base (USDIB) encompasses more companies than the UK, France, and Germany combined. However, despite the size and scope of the

defense industry (in terms of the number of companies and their area of expertise) its overall structure and well-being depends greatly on the viability of the large companies at the top of the industry. Only the very large corporations (e.g., Lockheed Martin, General Dynamics, Boeing) possess the capital necessary to undertake large defense projects and many smaller defense-related companies are almost entirely dependent upon subcontracts from the major corporations. As noted, USDIB is comprised of many large and small firms. A range of 8 to 10 major defense contractors, as depicted in Table 2¹⁶, dominate most large defense contracts.

COMPANY	DOD CONTRACT*
1. Lockheed Martin Corporation	\$17.0
2. Boeing Company	\$16.6
3. Northrop Grumman Corporation	\$8.7
4. Raytheon Company	\$7.0
5. General Dynamics Corporation	\$7.0
6. United Technologies Corporation	\$3.6
7. Science Applications International Corp.	\$2.1
8. TRW Inc.	\$2.0
9. Health Net Inc.	\$1.7
10. L-3 Communications Holdings, Inc.	\$1.7
Total of All DOD Contractors	\$170.8

*Value in Fiscal Year 2002 billions of dollars

Table 2. Ten Largest Military Contractors Fiscal Year 2002

In recent years, due to the on-going War on Terrorism, and Operations Iraqi Freedom and Enduring Freedom, the

¹⁶ Sources: "Vital Statistics: The U.S. Military." The Defense Monitor, Center for Defense Information, Volume XXXII, Number 5, November/December 2003. "100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards - Fiscal Year 2002." Director Headquarter Services. United States. Department of Defense. Center for Responsive Politics.

total U.S. defense budget has had a marked increase. Since 2001, the United States has slightly increased its defense spending as a percentage of its Gross Domestic Product (GDP) from the approximate three percent it was formerly spending. However, throughout the 1990s, the United States defense budget was in relative decline, as seen in Figure 2.17 Obviously, the increase in defense spending will help the U.S. defense industrial base.

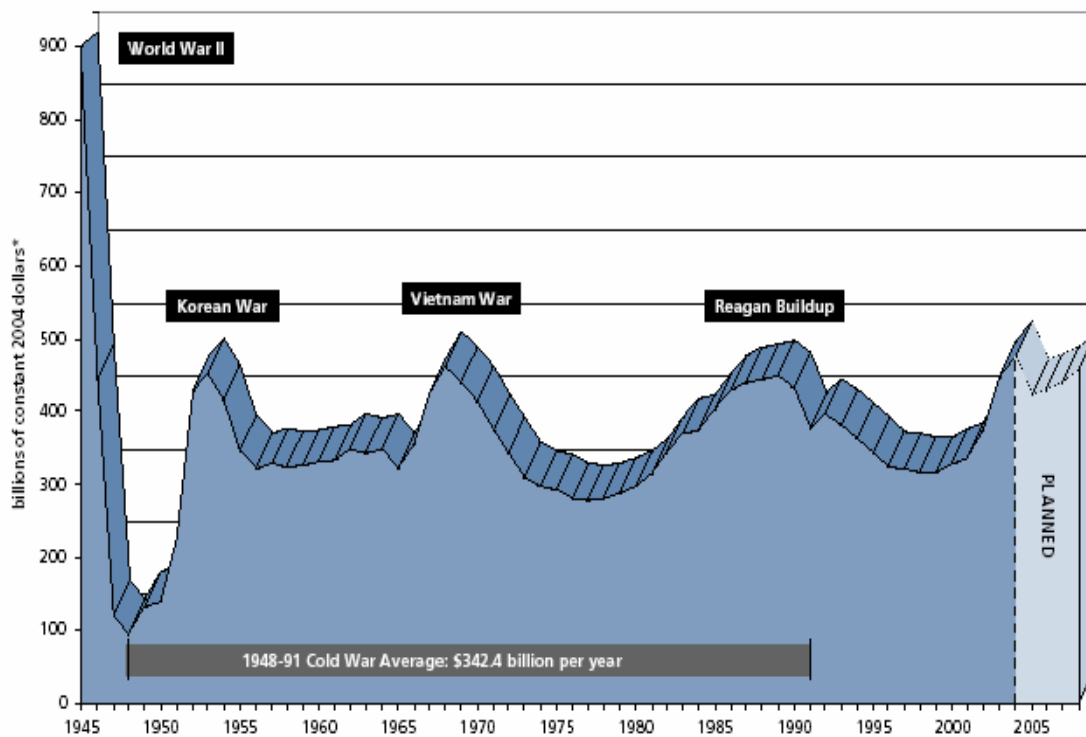


Figure 5. U.S. Military Spending Fiscal Years 1945 to 2008

¹⁷ "Vital Statistics: The U.S. Military." *The Defense Monitor*, Center for Defense Information, Volume XXXII, Number 5, November/December 2003. "National Defense Budget Estimates for FY2004." Office of the Under Secretary of Defense (Comptroller), March 2003. "Mid-Session Review, Fiscal Year 2004." July 15, 2003, Office of Management and Budget.

As previously mentioned, until the end of the Cold War, the USDIB faced the prospects of consistently declining defense budgets and overcapacity. The capacity problem was mitigated by a number of mergers and acquisitions among defense companies during the 1990s. The merger of actors within the USDIB could create an oligopoly of defense suppliers and inhibit DoD's ability to competitively award defense contracts to U.S. firms. The DoD tends to downplay the impact of defense industry mergers on competition and the effects of USDIB consolidation. However, it has not always been this way. From 1993 to 1998, the DoD advocated defense industry mergers and acquisitions as a way to reduce costs for both the industry and the government. In 1998, the DoD practically changed this direction when it opposed the proposed acquisition of Northrop by Lockheed Martin and the proposed acquisition of Newport News Shipbuilding by General Dynamics.

Garretty¹⁸ noted that the state of industry in the late 1990s prompted the USDIB to aggressively seek new markets for its products. Each venue represents difficulties and challenges that indicate that the USDIB must find other methods to deal with overcapacity in production and declining budgets. ICR&D could just be one such method. Other efforts and actions that the USDIB has actively pursued in recent years to mitigate the effects of the shrinkage in the defense markets include, but are not limited to, the following:

¹⁸ Garretty, Eric B. An Economic Analysis of Acquisition Opportunities for the United States Department of Defense within the Japanese Defense Industrial Base. Thesis. Naval Postgraduate School. December 2002.

- Expand the USDIB share of the international arms market; although this potential is limited by the tight government export controls and restrictions that exist, as well as the current limited defense spending capacity worldwide.

- Seek defense customers in the European Union. However, as noted above, European countries tend to purchase their defense equipment first from their own national sources, second from European sources or European cooperative programs, and lastly from U.S. defense companies. Furthermore, the European defense industrial base is also suffering from overcapacity and declining budgets. It is unlikely that the European defense industrial base can absorb the current USDIB overcapacity, and more unlikely since the threat of the Cold War is practically gone.

- Venture into the commercial marketplace with dual-use technology and products. The USDIB has aggressively taken steps toward this, especially the aerospace companies.

IV. MULTIPLE LAUNCH ROCKET SYSTEM

A. BACKGROUND

1. Program History

Multiple Launch Rocket System (MLRS) is a mobile rocket launcher that can fire the MLRS Family of Munitions (MFOM), a variety of surface-to-surface rockets that were later supplemented with an evolving series of surface-to-surface guided missiles. It was initially a free-flight artillery rocket system that greatly improved the conventional, indirect fire capability of the field Army. The system provides counter battery fire and suppresses enemy air defenses, light materiel, and personnel targets.

MLRS started life as the U.S. Army's General Support Rocket System (GSRS) program in the mid-1970's. In 1976, Concept Definition Study contracts were let to several companies and in 1977, Vought (currently Lockheed Martin) and Boeing were selected for competitive development.¹⁹ In December 1979, GSRS was renamed MLRS as it became an international partnership between the US, UK, France, and later Italy. In May 1980, Vought was announced the prime contractor for further development and production of the MLRS launcher and rockets. MLRS reached Initial Operational Capability (IOC) with the U.S. Army in 1983. Later in the same year, the Secretary of the Army approved both full-scale production of MLRS and type classification standard for major MLRS equipment. In February 1984, as a result of some MLRS items experiencing higher failure

¹⁹ United States. Department of Defense. Directory of U.S. Military Rockets and Missiles, Appendix 4: Undesignated Vehicles, MLRS. Report retrieved 13 March 2004 from website <http://www.designation-systems.net/dursm/app4/mlrs.html>.

rates, the MLRS Project Office Readiness Control Center was established to monitor world-wide Self-Propelled Launcher Loader (SPLL) status on a daily basis and to take immediate action to assure supportability of fielded MLRS units. By December 1986, a letter contract was awarded to Ling-Timco-Vought Aerospace and Defense (LTVAD) to provide initial support for the integration of the Sense and Destroy Armor (SADARM) submunitions into MLRS. The MLRS SADARM was a derivative of the existing MLRS rocket. It was envisioned that the descending submunition, using a dual-mode millimeter wave (MMW) and infrared (IR) sensor, would upon reaching and detecting a target, fire an explosively-formed penetrator (EFP) to impact the target from the top. In July 1988, a unit of the Oklahoma National Guard became the first National Guard unit to receive the MLRS system.

In February 1989 —two years behind schedule— DoD approved the system demonstration substage for the MLRS/TGW (Terminally Guided Warhead). Conditions for approval were that the U.S. Army had to do a Cost and Operational Effectiveness Analysis (COEA) comparing the MLRS/TGW to alternatives for defeating the armored threat, define specific actions to improve the ability to manufacture the submunition, and prepare a test and evaluation master plan defining specific quantitative test goals for entering into full-scale development.

Late in 1989, as part of the evaluation of the ablative metal blast panel configuration for the front of the MLRS launcher, 60 MLRS practice rockets were successfully flight tested in consecutive 12-round ripples. The metal blast panel was designed to protect the exposed areas of the M270 launcher from the high velocity gases

resulting from rocket motor operation. The new panels would replace the existing neoprene ablative panels that only provided protection from burn-through during the firing of only 108 rounds. While acceptable in peacetime, this limitation imposed severe restraints in battle. The design goal of providing protection for up to 540 rockets was exceeded during WSMR testing, during which 700 rounds were fired with no panel degradation. This effort was later accelerated as part of the MLRS Project Office's support for Operation Desert Storm.

Over time, the program slipped and encountered many difficulties. During 1990, the internationally funded MLRS/TGW competed with a previously classified U.S. program, the Brilliant Anti-armor Submunition (BAT) and other systems in a U.S Army "neck down" process. In March 1991, the Army selected the BAT. Congress would not permit continued funding of both the MLRS/TGW and BAT. Consequently, the United States withdrew from the MLRS/TGW program.

At the end of 1991, the Independent Software Integration Test (ISIT), a complex, contractor-operated system-level test, was successfully completed at Fort Sill, Oklahoma. The test was conducted using the European Heavy Army Scenario and performed with tactical equipment. This test was the pivotal event that proved the Fire Direction Data Manager (FDDM) system hardware and software architecture met system design criteria and operated very effectively during an intense combat scenario.

In the summer of 1993, full-scale production of the MLRS basic rocket ended. Minimum production of tactical warheads continued in order to maintain a warm production

line. After one year, the remaining tactical fleet of basic MLRS was converted to an Army Tactical Missile-capable Improved MLRS in the first and second quarters. The Terminal Guidance Warhead (TGW) program was terminated at the conclusion of the revised System Demonstration Substage (SDS). Also, the MLRS SADARM Program was terminated because of lack of funding. The MLRS/TGW was actually phase three of the multinational MLRS program.

One year earlier, as a result of Operation Desert Storm reviews, the Extended-Range (ER) rocket program, an enhanced version of the current rocket fired from the MLRS, was established and an Engineering and Manufacturing Development (EMD) contract was signed with LVS. The ER rocket was expected to have a range of 45 kilometers or greater, compared to the fielded rocket's 31.5 kilometers.

In the summer of 1995, the contract for development of the Improved Launcher Mechanical System (ILMS) was awarded. This modification of the MLRS M270 launcher would allow faster engagement of highly mobile, short dwell time targets. In May 1996, approval was given for the ER-MLRS program to enter Low Rate Initial Production (LRIP) and a contract for the initial quantity of ER-MLRS was awarded.

The MLRS Program is an ACAT IC Program and until 2000 the total number of systems produced was 857. The total program cost was \$2,300 million, and the average cost per unit was \$2.5 million.²⁰

²⁰ United States. Department of Defense. Director, Operational Test & Evaluation. "Fiscal Year 1999 Annual Report". Report retrieved 07 March 2004 from website <http://www.globalsecurity.org/military/library/budget/fy1999/dot-e/army>

2. Extent of International Cooperation

In July of 1979, the governments of the United States, Germany, France, and the United Kingdom signed a Memorandum of Understanding (MOU) for a joint development and production of a General Support Rocket System (GSRS). Later, within this year, GSRS was redesignated MLRS in order to be compatible with the name already established by the European allies. Thus, the GSRS Project Office became the MLRS Project Office effective with the redesignation.

One year later, the United States, the United Kingdom, Germany, and France signed a formal declaration of intent to participate in the concept definition phase of the terminal guidance warhead (TGW) program. The primary mission of TGW would be to provide rapid fire, non-nuclear capability to destroy a wide spectrum of stationary and moving, and medium hard to very hard, armored targets. The declaration required that the TGW be jointly developed, with active participation by industries of all four nations. In September of 1981, the four countries signed a supplement to the basic MLRS MOU of July 1979, providing for the concept definition phase of the TGW program. The United States would fund 40 percent, and each of the European allies would fund 20 percent. Three months later, concept/international program definition contracts were awarded to General Dynamics, Hughes Aircraft Company, Martin Marietta, Raytheon, and Great Britain's Hunting Engineering for a multinational development of TGW.

In July of 1982, an MOU supplement authorizing Italy's participation in the MLRS program was signed by all cooperating nations. By December 1983, the United States, France, Germany, and the United Kingdom signed an MOU

supplement to establish a TGW development program formally. At the end of November 1984, a cost-plus-incentive-fee contract for the cooperative development of TGW was awarded to a consortium of companies consisting of the Martin Marietta Corporation of the United States; Thomson Brandt Armaments of France; Thorn EMI Electronics, Limited, of the United Kingdom; and Diehl GmbH and Company of Germany. The remaining participant was MDTT, Incorporated, and a U.S. company with a fully integrated U.S.-European staff that acted as a management focal point for the joint venture. Two years later, in 1989, the European Executive Agency awarded the MLRS European production contract to the European Production Group of Munich, Germany.

The European Production Qualification Test (EPQT) began at White Sands Missile Range (WSMR) in late 1988 and in the following year, the development effort in support of the German AT2 warhead program and the European Production Qualification Test (EPQT) were successfully completed. Also, in the same year, the European Fly-to-Buy (EFTB) program began at WSMR. By the end of 1991 and after the successful performance of MLRS during Operation Desert Storm, planning began for development of an ER-MLRS as a successor to the Basic M26 rocket then in production. The improved rocket would provide the potential to engage additional threat systems, improve accuracy, create a safer environment for friendly forces, and provide a low-cost delivery vehicle for future smart munitions at extended ranges. Additionally, the Independent Software Integration Test (ISIT), a complex, contractor-operated system level test, was successfully completed at Fort Sill, Oklahoma. The test was conducted using the European Heavy Army

Scenario and performed with tactical equipment. This test was the pivotal event that proved the FDDM system hardware and software architecture met system design criteria and operated very effectively during an intense combat scenario.

At the beginning of 1992, the European Production Line was successfully certified as an MLRS qualified second source. Two months later the United States formally notified France, Germany, and the United Kingdom that it would not be a full participant in Full-Scale Development (FSD) of the MLRS/TGW. As noted above, the Army had selected the BAT system and Congress did not permit further funding. Finally, by 1994, the TGW program was terminated at the conclusion of the Revised System Demonstration Substage (SDS). Only the French government continued development of the submunition since the other three nations cooperating in the program chose not to continue the co-development effort. The European Production Line completed the delivery of the last European launcher. The German government conducted the first MLRS AT2 firing with live mines at WSMR.

B. PROGRAM ANALYSIS

To date, all operational requirements and capabilities have been met and the desired levels for readiness, reliability, and maintainability have been reached. However, delays in the MOU approval process adversely impacted the initiation of the cooperative Guided MLRS development phase. Several key problems encountered will be discussed below.

1. Coordination

Due to the number of partners, required coordination slowed the decision-making process. Experts on international programs agree that the complexity and difficulty of managing a successful international program increases by a high coefficient with each additional partner.²¹ The increased complexity in decision-making having four partners speaking different languages, having different political and acquisition systems, and cultures, challenged the MLRS/TGW program and impacted the schedule. In a survey, program officials unanimously agreed that two or three partners in the MLRS/TGW would have been easier to manage and less costly.²² They also believed fewer partners would have been more efficient for the program in terms of technical performance, program management, decision-making, and administrative issues.

2. Financial

Financial realignments and currency exchange rate fluctuations impacted the funding profile. For example, the more partners, the more problems a program will likely have in tracking and managing cost shares and work shares, which may be critical to ensure fairness in a multinational program. In the MLRS/TGW, the 40-20-20-20 cost share was tracked and managed in accordance with the MOU. Under the agreement, exchange rate fluctuations and inflation in any of the countries affected the cost shares and work shares.

²¹ D'Agostino, David M. "Transatlantic Cooperative Weapons Development." Acquisition Quarterly. Fall 1996.

²² Ibid

3. Work Shares

The work share expectations proved difficult to achieve during development. The program was set up to adjust the work share to cost share on the basis of cost in order to ensure equal shares. Therefore, if a company were performing a development task and began to exceed the estimated cost of the work substantially, that task would be moved or subcontracted to another company within the same nation. Although this was a difficult process to implement, some former project officials noted this had a side benefit of helping identify companies with technical and cost problems and of making adjustments to solve them.²³

4. Requirements Generation

The program requirements were not well defined. The program got underway with only the most general agreement on the need for a tank-killing submunition for use behind forward lines and the broad technical approach. However, the four governments ignored this concern because they could not agree on the threat details and moved forward instead. Throughout much of the component demonstration phase, the four nations continued to debate the specific characteristics of the threat. As late as 1992, the U.S. Army Operational Requirements Document (ORD) for the MLRS/TGW remained in a draft form.

Many programs during that period were dealing with an evolving threat. Two changes in the requirements negatively affected the program's already high technical risk and ambitious schedule. First, the requirements changed due to a newly projected reactive armor threat.

²³ D'Agostino, David M. "Transatlantic Cooperative Weapons Development." Acquisition Quarterly. Fall 1996.

Early on, the United States and the United Kingdom believed the Future Soviet Tank would require the MLRS/TGW to have a more robust lethal capability than did Germany and France. This caused the program to switch to a more lethal submunition with a dual-shape charge. Hence cost, schedule, and technical problems ensued in the program. In the end, the U.S. and UK agreed with the French and German approach. Second, about halfway through the development effort, France and Germany raised a new requirement to overcome the effects of highly reflective snow. This new requirement forced the program to add a backup seeker with Doppler beam sharpening to the development effort.²⁴ This backup seeker also caused the team to design and to develop another type of signal processor. This increased the technical risk and was later considered unnecessary.

5. Production Lines

Initially, the partners agreed that all requirements would be served from one integration line in the U.S. with the components coming from the other three countries' facilities. This seemed logical since the U.S. company's strength was integration. In 1990, however, the European partners insisted on a second, European integration line despite the likely quantity reduction in all the partner's requirements. On one hand, Europeans might have pressed for a second production line because they wanted to make third country sales freely, even though that required the unanimous prior approval of all the participants in conformity with the signed MOU. On the other hand, it appeared that U.S. and European partners decided to pursue

²⁴ D'Agostino, David M. "Transatlantic Cooperative Weapons Development." Acquisition Quarterly. Fall 1996.

a full-production capability. If the program had reached the production phase, two lines would have obviated any unit cost savings during the production phase and would have added to all the partners' production costs.

6. Use of a Consortium

Rather than assign one company the role of the prime contractor, the four companies formed a joint venture consortium, named MDTT, Inc., to sign the contract and to provide overall management. The governments supported this approach mainly for financial reasons. That was a good idea because a consortium would avoid the high overhead costs of a prime contractor being added to the program. However, awarding a cost-plus-incentive fee contract to a consortium resulted in delays and technical issues due to the lack of a prime contractor. First, little accountability existed in the consortium, and decision-making on work share was hampered by the lack of leadership in MDTT. In addition, there was no project management, planning, or risk analysis from the companies. If there had been a prime contractor, then he would have selected the best companies for the development tasks, determined work share more on the basis of technological strengths of the companies, and better managed the contractor efforts.

7. Lack of Qualified Staff Members

MLRS/TGW had an international project office as opposed to European liaison officers. They did not represent a full complement of "program office level" decision-makers from their countries and were not vested with decision-making authority. European liaison officers made periodic visits to the project office, located at the U.S. Army Missile Command, for Technical Working Group

meetings and other events. Another problem was the serious delay in establishing a limited European government balance in the international project office. If all the staff had been located fulltime in the international project office, then a greater team culture would have been established. In fact this would have resolved many of the language barriers, nationalistic pride issues, and decision-making obstacles the program experienced. Periodical visits always generate a formal atmosphere and do not generate a free-speech environment for problem solving.

8. Technology Disclosure and Export Licensing

Related to the lack of a team culture, was the limited sharing of "national assets." Countries that had some background data on technologies that were critical to program success did not broach the data in discussions and did not share it in an open and honest environment. If such critical data had been shared, many technical problems would have been more easily resolved. In order to achieve the best possible result, one must exclude national and international politics from the program's decision-making to the maximum extent possible and focus one's energy and efforts on doing what is best for the program's success.

9. Lack of Flexibility

MLRS/TGW adopted a consensus decision-making approach, with a three-level structure to oversee program execution and management. The Joint Steering Committee (JSC) was the top level of decision-making and was composed of senior national representatives at the 2-star level. It was the decision-making body that had the power to redirect the program. The next level was the Executive Management Committee (EMC) at the Colonel-level, chaired by the U.S.,

which reports to the JSC. EMC performed cost, schedule, and performance oversight and met every six months. The next level comprised the technical, cost, and test working groups. These groups worked through the day-to-day challenges of the program. Disputes that could not be resolved at the lowest levels were escalated up the aforementioned chain. The U.S.-based MLRS/TGW program office was the "residence" for liaisons from each country. During the implementation of the program, it was observed that a response to a single question sometimes took months. Furthermore, the U.S. Government personnel and contractors found that problems they normally solved in one simple meeting frequently took three. Another issue that counted more for some partners was the holidays and vacations that delayed the process in decision-making. For instance, no program activity could be scheduled during the month of August, the traditional month of vacations in Europe. Another observation was that the European partners often united and "out-voted" the U.S. decision-making in MLRS/TGW; this was "nominally consensus" but, in reality, it was a process based upon threat of veto instead of true vote.

When the parties could not reach a consensus, then the issue became a matter of "who screamed and pounded the table loudest." On the other hand, if a partner felt strongly about an issue, it might threaten to veto a decision, which could stop the program. That approach quite often resulted in a negative mode of decision-making rather than positive agreement and compromise.

C. CURRENT STATUS

The requirements for longer-range rocket artillery have led the U.S., France, Germany, Italy, and the UK to the cooperative development of Guided Multiple Launch Rocket System (GMLRS). GMLRS is a guided rocket with significantly increased range and accuracy.

In late 1998, the GMLRS program entered a four-year Systems Development and Demonstration (SDD) phase, and the final production qualification tests were successfully completed in December 2002. In March 2003, the M30 GMLRS rocket was approved for low-rate initial production, and Initial Operational Capability is scheduled for 2005. Under the LRIP-I contract, 156 GMLRS rockets were to be produced. A unitary variant of the GMLRS with a single warhead is being developed and Lockheed Martin was awarded an SDD contract for the unitary variant in October 2003 with completion scheduled for 2007. Lockheed Martin has recently received \$85 million from the U.S. Army to produce 840 Guided MLRS rockets under Low-Rate Initial Production II (LRIP-II) contract. Table 3 depicts the latest and projected activities for MLRS.²⁵

TIME/PERIOD	ACTIVITY
3QFY2002	EMD Critical Design Review
1QFY2003	Production Qualification Test Flight Readiness
2QFY2003	Product Definition Data Package Completion
3QFY2003	Low-Rate I Initial Production Decision
3QFY2005	Initial Operational Test
2QFY2006	Milestone III Decision - Initial Operational Capability

Table 3. Latest and Projected Activities for MLRS

²⁵ From Army Technology website. Report retrieved 09 March 2004 from <http://www.army-technology.com/projects/mlrs.html>.

Lockheed Martin Missiles & Fire Control-Dallas, Diehl Munitions Systeme, GmbH & Co. KG, and MBDA (a formation of Matra BAE Dynamics, EADS Aerospatiale Matra Missiles and Alenia Marconi Systems missile activities) signed MoA's at the Paris Air Show in June 2001, in order to establish a European Prime Contractor for the production phase of this transatlantic cooperation program. Lockheed Martin and Diehl agreed to extend their Euro Rocket System (ERS) GmbH joint venture to incorporate MBDA as a third partner. ERS is a 50-50 joint venture between Lockheed Martin and Diehl, under German law, responsible for the area of MLRS business in Europe. The extended ERS Company would work with FiatAvio to establish an industrial team, representing all five cooperating countries. Further, broader industrial participation in production would be established within Europe.

Lockheed Martin is the Prime Contractor for MLRS/GMLRS in the U.S. The European Prime Contractor aims to supply GMLRS into a large domestic and third party market beginning in 2005.

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V. MEDIUM EXTENDED AIR DEFENSE SYSTEM

A. BACKGROUND

1. Introduction

In today's world geopolitical environment, the United States is increasingly operating as part of a multinational coalition deployed outside of NATO Europe, whether as part of a NATO-led or NATO-endorsed effort, or part of some other internationally sanctioned multi-national operation. This has led both U.S. and European policy-makers to require that theater missile defense (TMD) systems be able to protect deployed joint and combined forces engaged in everything from major regional conflicts (MRCs) to humanitarian and non-combatant evacuation operations (NEO). The nature of future coalition operations demands that TMD systems possess a high level of interoperability and be made easily and rapidly transportable to any theater of operations.²⁶

Although all NATO members agree on the need for a TMD capability, only the United States, Germany, and Italy have agreed collectively to develop a TMD system within NATO that is capable of meeting both collective defense and security challenges. The Medium Extended Air Defense System (MEADS) represents this needed TMD system. MEADS is an international trilateral TMD program and cooperative effort involving the United States, Germany, and Italy, to develop an air and missile defense system that is mobile and transportable. It will be capable of countering

²⁶ Rudney, Robert. "The Contribution of the Medium Extended Air Defense System (MEADS) to the U.S. Post-Cold War Strategy." Comparative Strategy. 1997.

ballistic missiles and air-breathing threats such as aircraft, unmanned aerial vehicles, and cruise missiles. MEADS will improve the limited area defense of vital assets, both civilian and military, defend troops and fixed assets, as well as provide capability to move with and protect the maneuver of forces.

2. Origins and Evolution of MEADS

The MEADS program originated in 1989 as the Corps Surface-to-Air Missile (Corps-SAM), a U.S. Army concept for replacing the aging HAWK (Homing All-the-Way Killer) Surface-to-Air System (SAM). In order to improve its chances for funding, Corps-SAM evolved into a joint program between the U.S. Army and U.S. Marine Corps to fill the void that would be created by the retiring HAWK system, which had a life cycle extension into 2010.

From the beginning, the Corps-SAM concept was envisioned as part of a layered air and missile defense architecture, filling a critical layer between the man-portable Stinger SAM and fixed, rear-end defense provided by the Patriot and the upper tier THAAD (Theater High Altitude Air Defense).²⁷ Corps-SAM, differently from any other TMD program, integrated three unique mission capabilities into one system: mobility, transportability, and target engagement diversity. As such, using the combat proven Patriot Advanced Capability-3 (PAC-3) missile, MEADS role in ballistic missile defense will be to bridge the gap between man-portable systems and the higher levels of the Ballistic Missile Defense Systems (BMDS), while providing

²⁷ Rudney, Robert. "The Contribution of the Medium Extended Air Defense System (MEADS) to the U.S. Post-Cold War Strategy." Comparative Strategy. 1997.

continuous coverage for rapidly advancing maneuver forces.

Additionally, the system was to be mounted on a wheeled vehicle to travel on unimproved roads and cross-country with maneuver forces. For transportability, MEADS needed the ability to move using tactical aircraft such as the C-130 instead of the large strategic airlift vehicles like the C-141, C-17, or C-5. Corps-SAM was to be the only air-defense system able to roll off transports with the troops and immediately begin operations.

Because of the diversity of the desired mission capabilities and the anticipated advancements in technologies needed for a relatively small, mobile, yet powerful radar, Corps-SAM evolved into a follow-on to the Patriot rather than a mere HAWK replacement. However, the high technology involved and the complexity of designing a single system capable of providing three different mission capabilities implied a very expensive defense system. In the early 1990's, with the end of the Cold War, the demise of the Soviet threat, the results of the Gulf War, and declining domestic defense budgets, it seemed unlikely that the U.S. Administration in office at the time would embark on such a costly program. Although the Office of the Secretary of Defense (OSD) had approved the system concept, it also directed that the Army seek and secure allied participation before system development approval. Thus, the Corps-SAM program survival depended upon finding international partners. The Army was successful in finding U.S. allies that were interested in jointly acquiring a new air and missile defense system.

3. From Corps-SAM to MEADS

With the events of the Gulf War, Europe further realized the need for a TMD capability to protect forces and territory. Four NATO members (France, Germany, Italy, and the United Kingdom) had a requirement to replace their respective HAWK missiles with a rapidly-deployable system that would protect their forces from ballistic missile attack, yet each country had different concepts and systems in mind.

The United Kingdom held off committing itself to any ongoing TMD effort until it completed a feasibility study that examined threats, requirements, and funding constraints. In February 1994, the United States officially invited and convinced Germany to merge its concept system (the TLVS or "Taktisches Luft-Verteidigungs-System") with the Corps-SAM in the system's development and production. Germany never actually intended to build TLVS on its own because of the costs involved. France and Italy also joined, after Germany, but without abandoning their own HAWK replacement program (the SAMP-T or "Sol Air Moyenne Portee-Terre"). In 1995, the United States, Germany, France, and Italy signed an initial statement of intent to collaborate on a common TMD system based on Corps-SAM, dividing costs and development. Corps-SAM's name consequently changed to MEADS.

In May 1996, after delaying the signing of the official agreement by five months, France withdrew from the multinational effort, citing budgetary reasons and asserting that MEADS did not correspond to its strategic needs. The United States viewed France's withdrawal as an attempt to undermine the trans-Atlantic effort and draw

Germany into its own SAMP-T program. The same month, however, the United States, Germany, and Italy agreed to pursue the project definition and validation phase of MEADS without France. The burden of costs and development would be shared, with the United States bearing 60 percent, Germany 25 percent, and Italy 15 percent.

At the time, MEADS represented an innovative approach to trans-Atlantic armaments cooperation that was to set the tone for future collaboration on major military programs. Since the 1960s, trans-Atlantic arms cooperation projects have suffered a 50 percent cancellation rate, while intra-European programs have failed less than eight percent of the time.²⁸ These statistics depict how recurring challenges have complicated U.S.-European arms cooperation. First, the major powers have been reluctant to compromise on national military requirements. Second, the major powers have been afraid to depend on other nations to meet fundamental, even strategic, security needs.²⁹ American allies are reluctant to join trans-Atlantic programs where European countries are junior partners, fearing that the United States will ignore their interests. However, if both sides share the project evenly or when it is in their interest (such as programs enabling European nations to benefit from access to U.S. advanced technology), then European allies favor cooperation.³⁰ MEADS seemed to be the case for the latter.

²⁸ Grant, Robert. "Transatlantic Armament Relations Under Strain." Survival 39. 1997.

²⁹ Ibid.

³⁰ Ibid.

MEADS also benefited from the Department of Defense's new leadership in 1993 (the start of the Clinton Administration), which provided political support to improve NATO armaments cooperation. Thus, in the two years from 1994 to 1996, the number of international programs tripled from 40 to 120. However, only three were major initiatives: the Multifunction Information Distribution System (MIDS), the Joint Strike Fighter (JSF), and MEADS. The United States cited several reasons favoring NATO European allies to enter the MEADS program. First, the U.S. argued its armaments policy shift under the Clinton Administration would improve and streamline trans-Atlantic cooperation. Second, MEADS would strengthen the U.S.-European allies' military and industrial relationship into a more binding, long-term security relationship. Third, MEADS would represent preparation for coalition operations by achieving interoperable equipment requirements and common logistics capabilities. Fourth, MEADS would allow nations to acquire a critical weapon system when constrained defense budgets prohibited pursuing such a venture on a unilateral basis.³¹

The MEADS project passes through three phases. The participating countries negotiate a Memorandum of Understanding (MOU) for each of these phases: Product Definition/Validation (PD/V), Design and Development (D&D), and Production. MEADS is currently in the first stage, PD/V. In 1999, MEADS was restructured to add a Risk

³¹ Engelhardt, Robert. The Medium Extended Air Defense System: A Renaissance in Trans-Atlantic Armaments Cooperation? Thesis. Naval Postgraduate School. March 1999.

Reduction Effort (RRE) to the PD/V phase. The primary objectives of MEADS RRE are to:

- Demonstrate an integrated MEADS system concept incorporating the PAC-3 missile.
- Reduce the overall program's technical, schedule, and cost risk.
- Develop the international cost and schedule consensus for the MEADS program.

During this phase, a decision was made to incorporate the Lockheed Martin PAC-3 missile into the system. The German and Italian governments called for a study on introducing a second missile into the program in addition to the PAC-3.

In May 1999, the NATO MEADS Management Agency (NAMEADSMA), a chartered organization of NATO, selected MEADS International, Inc., to develop MEADS. A multinational joint venture headquartered in Orlando, Florida, MEADS International's participating companies are MBDA Italia, EADS European Aeronautic Defence and Space Company and LFK-Lenkflugkörpersysteme (LFK, a subsidiary of EADS and MBDA) in Germany, and Lockheed Martin in the United States. In October 2002, the OSD approved a proposal from the Missile Defense Agency (MDA) to transfer management of the MEADS program from MDA to the Army. On April 30, 2003 at a meeting of the Defense Acquisition Board (DAB), the DOD approved the Army's plan to pursue a combined Patriot and MEADS evolutionary development plan.

4. NATO Participation in MEADS

As previously mentioned, the United States invited the major European defense-producing nations to join the MEADS program. Each had a different reason to join, or not, the

program and each decision essentially reflected the country's political-military history. Germany and Italy defense policies have traditionally followed NATO policy, while France and the United Kingdom have maintained a more independent status. Several factors affected European participation in MEADS: the impact of the Gulf War, post-Cold War budget constraints, wariness regarding U.S. bureaucratic and political practices, and the understanding that trans-Atlantic cooperation remains central to each nation's security.³² Germany, as the leading partner in the MEADS cooperative program, and one of only two countries that have joined the program so far, will be the focus of NATO participation in MEADS.

a. Germany

By 1993, Germany was facing the continuing costs associated with reunification, and a high level of unemployment. Other national priorities, as mentioned above, outweighed any expensive defense program. However, the impact of the Gulf War, the proliferation of weapons of mass destruction, and the vulnerability to tactical ballistic missiles eventually led Germany to accept and pursue a TMD system. Reunification was considered a long, costly, and dedicated process. Meanwhile, it seemed logical for Germany to depend upon the United States by working with and relying on the U.S. for a TMD system instead of pursuing a more independent program.³³

³² Engelhardt, Robert. The Medium Extended Air Defense System: A Renaissance in Trans-Atlantic Armaments Cooperation? Thesis. Naval Postgraduate School. March 1999.

³³ Ruhle, Hans. "Ballistic Missile Defense: A German View". Comparative Strategy. 1993.

Hence, by early 1995, Germany focused on who should build the TMD system, instead of how. The German TLVS, originally conceived to contend with Soviet air attacks, no longer had the capabilities required in the new security environment. Furthermore, defense-spending constraints meant that TLVS could only be built through an international partnership. This left Germany with three options: partner with the United States (Corps-SAM), with France and Italy (SAMP-T), or all three. Each option involved political, military, and industrial advantages and disadvantages.

From a political standpoint, several reasons inclined the balance toward U.S. partnership. First, the U.S. counter-proliferation strategy was multi-faceted. Second, partnership with the U.S. would remove Germany from Congressional criticism. Third, close trans-Atlantic cooperation was in Germany's utmost security interests. And fourth, European public opinion was very sensitive over TMD systems and tactical ballistic missiles (TBMs), as they were manufactured on the continent.

The principal military reason for partnering with the U.S. was the German Air Force, which had positive and close cooperation with the U.S. on air defense systems. It believed that MEADS would satisfy NATO requirements for interoperability, it favored U.S. technology, and, ultimately, it sought U.S. equipment in case a European crisis ever emerged again so they would not rely on a potential European enemy for military equipment.

In the industrial arena Germany was more wary, knowing that the U.S. financial, industrial, and technological dominance would overcast German companies.

Furthermore, there was also wariness of the internal competing interests of the U.S. military and industrial sector, as well as the unpredictable executive-legislative actions. However, the importance placed on trans-Atlantic TMD cooperation outweighed any concern, although compelling political reasons favoring cooperation with the French existed. Germany favored a U.S.-European effort, but did not believe that France would abandon the French-Italian SAMP-T for an entirely new system. Although France presumably delayed and eventually withdrew from the MEADS program in an effort to divert Germany toward its own TMD program, the SAMP-T, Germany eventually decided on the MEADS system.

b. Italy

The reason that Italy, with a small defense budget, would pursue two extended air defense systems (MEADS and SAMP-T) that appear to possess similar capabilities is not clear. As with Germany, the main reason for Italy may be pragmatism. Aware of its own immediate vulnerability to TBMs and the U.S. dominance in BMD programs, Italy would be imprudent not to work with the United States on a TMD system.³⁴ Furthermore, once the Italian Government has approved a multinational project, international commitment ensures steady funding from start to finish for the Italian Services, which already compete for limited funds. Even though Italy recognizes international cooperative efforts are more expensive than purchasing equipment off-the-shelf, the benefits of access

³⁴ Engelhardt, Robert. The Medium Extended Air Defense System: A Renaissance in Trans-Atlantic Armaments Cooperation? Thesis. Naval Postgraduate School. March 1999.

to technology, employment in Italian enterprises, and strengthened political ties can be more important than immediate cost-savings.³⁵

c. France

Although France's role in MEADS was brief, from 1995 to 1996, it depicted the French's own perception of its national interests and those of its European neighbors. To France, all arms and weapons systems should be developed and produced in and by Europe, and to France "Europe" means French leadership. France does not want to leave the U.S.-dominated world market for medium-range and longer-range ground-based air defense systems to the United States alone, and it does not want Europe to remain dependent on U.S. systems.³⁶ The French have, nonetheless, recognized their need to maintain close ties with the United States.

d. Prospective Partners

As previously mentioned, the United Kingdom withheld participating from the start of the program, arguing it required feasibility studies examining existing threats, requirements, and budget constraints. To date, several studies have been conducted and all seem to indicate and conclude that the United Kingdom does not see an immediate threat from Europe's southern periphery in the near future, the defense budget does not allow a TMD program, and because of the nature of current multinational missions, it can eventually rely on the U.S. to provide TMD for British forces. The studies further suggested that the

³⁵ Engelhardt, Robert. The Medium Extended Air Defense System: A Renaissance in Trans-Atlantic Armaments Cooperation? Thesis. Naval Postgraduate School. March 1999.

³⁶ Mey, Holger. "Extended Air Defense - Germany Between European and Transatlantic Orientations." Comparative Strategy. 1995.

United Kingdom was more interested in naval-based programs than ground-based programs due to their location in the European continent.

Since 1998, other HAWK-equipped NATO members have been expected to join the MEADS program (the Netherlands, Turkey, Greece, among others), but to date none has done so. European participation has been driven by the dominating U.S. lead and experience in TMD technologies and infrastructure. While recognizing the need to partner for effective TMD capability, nonetheless, each side remains cautious of each other. Europe because of the U.S. bureaucratic interactions, and the U.S. because of technology transfer issues in order to maintain their position as a super power.

5. Domestic Perspectives on MEADS

For Germany and Italy, MEADS has always been a top priority. Fielding MEADS on schedule is critical because neither country currently has a TMD capability sufficient for the new security environment. For the United States, however, while a mobile TMD capability remains a stated requirement, other TMD programs like the Patriot PAC-3 and THAAD are deemed a higher priority and more urgent than MEADS. As such, MEADS has been categorized as a follow-on system and consequently lacked the necessary long-term dedicated funding. MEADS was even excluded from the 1999-2004 Program Objectives Memorandum (POM).

For instance, according to a 1998 General Accounting Office (GAO) Report, the Ballistic Missile Defense Organization (BMDO) could not provide the \$1.4 billion needed for fiscal years 2000 through 2005 unless the DoD (1) increased BMDO's total obligational authority; (2)

extended the development and production of programs, such as PAC-3, THAAD, and Navy Area systems; or (3) drastically reduced BMDO funding earmarked for targets, systems integration and test, and management.³⁷ As France had predicted, MEADS' weaknesses resulted not from European actions, but from internal U.S. politics. By 2004, the United States had decreased its funding for MEADS from the initial 60 percent to 55 percent. Germany and Italy absorbed these costs, increasing burden sharing from 25 to 28 percent and from 15 to 17 percent, respectively.

The U.S. Defense Industrial Base (USDIB) regarded MEADS as critical due to what its failure might mean to trans-Atlantic cooperation and because the European arms market might be closed to U.S. defense firms by the creation of a "Fortress Europe" mentality. Furthermore, the DoD's handling of MEADS could harm the U.S.'s ability to conduct business in Europe. Eventually, Germany, Italy, and the USDIB recognized the effects of U.S. political and bureaucratic factors in undermining MEADS and consequently the future of trans-Atlantic arms cooperation. In the end, the U.S.'s credibility as a partner for future cooperative armaments ventures has suffered most.

As for technology transfer, the United States has always established procedures for releasing sensitive national security-related information to foreign governments and companies. These policies aim to preserve U.S. military technological advantages. Control policies limit the transfer of advanced design and manufacturing

³⁷ United States. General Accounting Office. Defense Acquisition: Decision Nears on Medium Extended Air Defense System. GAO/NSIAD-98-145. June, 1998.

knowledge and information on system characteristics that could contribute to the development of countermeasures. BMDO's summary statement of intent did not address technology transfer issues that continue to trouble the MEADS program. Although the statement recognized that classified information developed for other missile programs would be transferred to the MEADS program, the statement did not address whether the programs that owned that information had concerns about its release. Also the BMDO did not address the impact that a decision to withhold critical information could have on executing the program.³⁸

Technology release policies present special challenges for the MEADS program because they involve several sensitive technologies critical to preserving the U.S. military advantage, especially the PAC-3 missile. These policies limit the ability of contractors to leverage the use of existing missile system technology and pursue the cheapest technical solution. German and Italian defense officials and the European contractors involved in the MEADS program said that unless they can assess the U.S. technology that U.S. contractors are using, they cannot be sure the technology is the best or the cheapest available.³⁹ For the international system to be truly interoperable, DoD may have to provide information that it has been reluctant to share. For instance, the United States has been reluctant about providing critical technological information on the PAC-3 missile developed by the U.S. firm Lockheed Martin. The battle-proven PAC-3 missile is the

³⁸ United States. General Accounting Office. Defense Acquisition: Decision Nears on Medium Extended Air Defense System. GAO/NSIAD-98-145. June 1998.

³⁹ Ibid.

world's only fielded hit-to-kill, kinetic energy air defense missile. It defeats the entire threat to the Patriot Air Defense System: TBMs carrying weapons of mass destruction, advanced cruise missiles, and aircraft. Thus, the PAC-3 missile represents an important and critical technological advantage for the U.S.

Additionally, when MEADS was designated as a follow-up to Patriot, and the PAC-3 missile became the focus of the system, Germany and Italy essentially had to adhere to the "Buy American Act." However, current U.S. arms controls have allowed neither Germany nor Italy to benefit extensively from access to U.S. advanced technology.

B. PROGRAM ANALYSIS

1. The Reasons for MEADS

The desire of the United States, Germany, and Italy to develop MEADS jointly emerged from the post-Cold War reality of reduced defense budgets and the need to share the costs of expensive systems. For the United States, NATO MEADS was the only way to keep its original Corps-SAM funded. In order to achieve international support, the U.S. —under the Clinton Administration— promised a new approach to armaments cooperation that would ease technology sharing and would equitably divide the program's development and production work share. A joint cooperative effort with U.S. allies was considered the best means of acquiring MEADS because it reduced cost, improved political ties, and built a more effective coalition force. However, the DoD did not fully assess funding and technology transfer issues before initiating the international program, and thus it may not be able to achieve these benefits.

For Germany and Italy, cooperation with the United States was necessary not only for budgetary reasons, but because of the dominant lead the U.S. possesses in missile defense technologies, research and development, and operational experience. At the same time, however, German and Italian concerns over the tendency for internal U.S. bureaucratic processes to derail international projects was set aside because of the promise of a renaissance in armaments cooperation.⁴⁰

The cancellation of the MEADS program would have immediately affected the U.S. Ballistic Missile Defense (BMD), since the ability of other systems to meet MEADS requirements is limited. The Navy Area Wide (NAW) system may not be capable of protecting the maneuver force because its defended area will be limited by the distance from which it must stand off shore and the range of its interceptor. Ultimately, the NAW system has been cancelled. The Theater High Altitude Air Defense (THAAD) and Navy Theater Wide (NTW) systems are being designed to engage primarily medium-range ballistic missiles, but THAAD cannot defend against theater ballistic missiles launched from very short ranges, aircraft, or low-altitude cruise missiles.

2. U.S. Internal Factors Affected MEADS

Domestic U.S. political and bureaucratic factors reminiscent of Cold War experiences resurfaced and jeopardized the U.S.'s participation in MEADS, almost killing the project in the beginning. The United States

⁴⁰ Engelhardt, Robert. The Medium Extended Air Defense System: A Renaissance in Trans-Atlantic Armaments Cooperation? Thesis. Naval Postgraduate School. March 1999.

was unwilling to risk the stability of higher priority domestic TMD systems in order to fund MEADS. Instead, the U.S. presented an alternative U.S. concept to Germany and Italy that would be more affordable but probably less capable than MEADS. Eventually, the PAC-3 alternative was accepted and is currently the system underway. The Europeans declared that if MEADS failed because of U.S. political actions, NATO Europe would exclude U.S. defense industries from European markets and turn inward to a policy of developing and procuring arms exclusively within Europe.

To date, the United States, Germany, and Italy, have compromised on a mutually acceptable solution to MEADS because of their shared common interest in preserving a strong NATO to ensure continued European stability. This compromise, however, does not conceal that MEADS was almost cancelled due to U.S. political and bureaucratic reasons. Instead, this compromise only increases the concerns of NATO European countries over any future effort to cooperate with the United States in major trans-Atlantic armaments enterprises.

3. Initial Funding Dilemma

A compromise on MEADS has not improved the United States' credibility as an international armaments partner, especially with the unstable and contradictory position assumed by Congress and DOD regarding funding for the initial years of the program. The multilateral statement of intent showed that the partners intended to develop and produce MEADS together, but little attention was given to MEADS funding needs subsequent to the project's definition and design. The summary statement of intent did not

address the long-term funding needs by fiscal year. Instead, it indicated that funding beyond fiscal year 1999 would be derived from funds budgeted to develop an advanced theater missile defense capability.

BMDO initially was unable to acquire MEADS without impacting higher priority missile defense programs unless the DoD or the U.S. Army provided additional funds. The BMDO's budget plan did not include funding for MEADS after fiscal year 1999 because the organization's budget was dedicated to missile systems that would be available sooner. Over the next six years, up to 2005, for which BMDO budgeted, the organization needed \$1.4 billion to execute the planned MEADS program. Because it had difficulty funding MEADS, BMDO considered various program options to find a less costly acquisition program, including terminating the program that had started as a United States' initiative and proposal for international cooperative research and development. As noted, the U.S. was motivated to make the program economically attractive to the possible participants by offering flexible burden sharing arrangements and compensating more of the costs than the other participants because it was in the U.S. Army's interest to secure international funding. However, MEADS lacked Congressional political backing and DOD economic support from the start.

4. Technology Transfer Concerns

The summary statement of intent did not address technology transfer issues that continue to trouble the MEADS program. The statement recognized that classified information developed for other missile programs would be transferred to the MEADS program, but it did not address

whether the programs that owned that information had concerns about its release. Unless the European partners and their respective contractors can assess the U.S. technology that U.S. contractors are using, these partners cannot be sure that the technology is the best or the cheapest available. For the MEADS program and any international cooperative effort to be truly interoperable and successful, the DoD must provide information that it has traditionally been reluctant to share. Germany has contended that the U.S. has not released enough technology and knowledge on time for MEADS.

C. CURRENT STATUS

In 2003, MEADS International submitted a solicited proposal for the Design and Development (D&D) Phase. The D&D contract is planned to begin in 2004 and would extend the MEADS program, which is currently near the end of a Risk Reduction Effort (RRE) contract, for seven years. In a contract milestone demonstration in 2003, the system demonstrated its ability to acquire, classify, track, and destroy simulated aircraft and missile targets in a successful System Level Interface Demonstration.

On September 10, 2003, MEADS International completed a successful series of demonstrations and tests of its advanced lightweight launcher prototype in Brescia, Italy, and released the first photographs of the launcher. The MEADS launcher, designed to initialize, self-load, and vertically launch up to 12 PAC-3 missiles rapidly, is able to roll-on/roll-off C-130 transport aircraft. The launcher tests included demonstrations of uploading and offloading representative PAC-3 missile canisters using a unique system that significantly reduces manpower from that

required by the current Patriot system. "The tests took place in the presence of military observers from the three nations co-developing MEADS," said MEADS International Chief Engineer Pietro Ragonese. "Military representatives from Germany, Italy, and the United States were all highly impressed with the simplicity of operating the launcher and its demonstrated unloading-reloading times, which were well within requirements stipulated by the three countries. The MEADS program remains on track and on budget."⁴¹ MEADS International developed the launcher with principal subcontractors MBDA-Italia, EADS/LFK, Lockheed Martin, ATIB, Rampini, and Stewart & Stevenson.

On March 4, 2004, Lockheed Martin's PAC-3 missile successfully intercepted and destroyed an incoming TBM in a test at White Sands Missile Range, New Mexico. The PAC-3 missile is the selected primary interceptor for the multinational MEADS.⁴² First low-rate production missiles were delivered to the U.S. Army in October 2001. A contract for 88 missiles was placed in December 2002 and for another 12 in March 2003. A total of 220 missiles are planned for procurement by 2004, when a decision on full-rate production is expected. The missile was first deployed during Operation Iraqi Freedom in March/April 2003.

As previously mentioned, MEADS is currently in the three-year RRE phase, awarded in July 2001, which is

⁴¹ MEADS International, Inc. "MEADS Advanced Lightweight Missile Defense Launcher Completes Acceptance Tests." Press Release by MEADS International, Inc. September 10, 2003. Press release retrieved 25 February 2004 from website <http://www.missilesandfirecontrol.com>.

⁴² Lockheed Martin Corporation. "Lockheed Martin's PAC-3 Missile Successfully Intercepts Tactical Ballistic Missile In Test." Press release by Lockheed Martin Corporation. March 4, 2004. Press release retrieved 10 March 2004 from website <http://www.missilesandfirecontrol.com>.

investigating measures to reduce development risks and costs for critical elements. These efforts include assessing technologies identified in the participating countries' evolving air defense concepts. RRE is on schedule for completion in 2004. Currently, the United States, Germany, and Italy are financing the program in shares of 55, 28 and 17 percent respectively. MEADS is expected to enter service in 2012.

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VI. JOINT STRIKE FIGHTER

A. BACKGROUND

1. Program History

The Joint Strike Fighter (JSF) program originated in the early 1990's by restructuring and integrating several DoD tactical aircraft and technology initiatives already underway at the time. The DoD's goal was to meet the future strike requirements of the U.S. and its Allies using a common family of aircraft and the latest technology.

In 1993, the Defense Advanced Research Projects Agency (DARPA) executed a program to develop a supersonic Short Take-Off and Vertical Landing (STOVL) aircraft as a replacement for the AV-8B Harrier. Additionally, the DoD was considering canceling the Navy's Advanced Attack/Fighter (A/F-X) that was slated to replace the General Dynamics/McDonnell Douglas A-12 Avenger II program for the U.S. Navy.

Senior leadership at the Pentagon suggested a Joint Attack Fighter (JAF) instead of the Navy's A/F-X program. The JAF would be cheaper than the A/F-X and would be designed with a common airframe suitable for the Navy, Air Force and Marine Corps. By using a common airframe, significant manufacturing and operational savings were expected. Many of the concepts associated with the JAF program were later incorporated into the Joint Advanced Strike Technology (JAST) program. Its single-engine design and commonality were among these incorporations.

The JAST Program was initiated in late 1993 as a result of the DoD Bottom-up-Review (BUR). The major tactical aviation results of the BUR were to cancel the

Multi-Role Fighter (MRF) and the A/F-X programs, continue the ongoing F-22 and F/A-18E/F programs, reduce F-16 and F/A-18C/D procurement, and initiate the JAST Program.

The JAST program office was established on January 27, 1994, with the mission of defining and developing aircraft, weapon, and sensor technology that would support the future development of tactical aircraft. The program subsequently moved from a broad, all-encompassing program to one that would develop a common family of aircraft to replace several aging U.S. and UK aircraft.

By the end of 1994, the JAST program had absorbed the DARPA Common Affordable Lightweight Fighter (CALF) program. CALF subsequently became the primary focus of the JAST program. Additionally, the JAST program was considering modifying the Conventional Take-Off and Landing (CTOL) versions of the aircraft to perform in a STOVL role in order to meet the needs of the Marine Corps. Consequently, Congress mandated the merger of JAST with the DARPA Advanced Short Take-Off/Vertical Landing program. The JAST Program initially explored a wide range of potential strike warfare concepts using six-month Concept Exploration (CE) study contracts awarded in May 1994. The findings of the CE studies showed that a common family of aircraft was the most affordable solution to meet the needs of each Service. The family of aircraft would comprise a single basic airframe design with three distinct variants: CTOL for the U.S. Air Force to complement the F-22 Raptor and replace the aging F-16 Fighting Falcon and the A-10 Thunderbolt; STOVL for the U.S. Marine Corps to replace both the AV-8B Harrier and the F/A-18 C/D Hornet; and a Carrier (CV)

variant for the U.S. Navy to complement the F/A-18 E/F Super Hornet.

Following numerous trade studies, two critical decisions were made: the JAST family of aircraft would be single-crew and single-engine. Navy attack/fighter aircraft previously possessed two engines due to safety concerns. The choice of a single-crew aircraft was accepted based on technology maturation and demonstrated reliability testing.

Boeing, Lockheed Martin, McDonnell Douglas, and Northrop Grumman were each awarded fifteen-month Concept Definition and Design Research (CDDR) contracts in December 1994. Northrop Grumman and McDonnell Douglas/British Aerospace teamed shortly after the CDDR contracts were awarded. The contractors refined their Preferred Weapons System Concept (PWSC) designs and performed a number of risk reduction activities (e.g., wind tunnel tests, powered-model STOVL tests, and engineering analyses).

In the spring of 1995, all three of the contractor teams selected derivatives of the Pratt & Whitney (P&W) F119 engine to power their aircraft. Consequently, P&W was awarded a contract for a preliminary design of each of the primary JSF engine concepts in November 1995. Concurrently, the DoD awarded General Electric a contract to investigate whether the GE F110 or YF120 could be developed into an alternate engine for one or more of the JSF variants. In 1996, the YF120 was identified as the best solution and GE initiated preliminary design efforts.

Several Defense Acquisition Board (DAB)-level program reviews were conducted in late 1995. The final Requests for Proposal (RFP) were issued to the contractors in March

1996. By that time the JAST program name had changed to Joint Strike Fighter (JSF).

In May 1996, JSF was designated an Acquisition Category I, DoD acquisition program. In June, the weapon system prime contractors submitted their Concept Demonstration Phase (CDP) proposals. The Under Secretary of Defense (Acquisition & Technology) signed a formal Milestone I Acquisition Decision Memorandum on November 15, 1996, clearing the way for the award of CDP prime contracts to Boeing and Lockheed Martin on November 16, 1996.

On November 16, 1996, the DoD announced that Boeing and Lockheed Martin had been chosen to compete in the concept development phase. Each contractor was tasked to design and flight-test a CTOL and STOVL version of the aircraft. On October 26, 2001, the DoD selected Lockheed Martin as the prime contractor for the Joint Strike Fighter Program.

2. Program Objectives

The Joint Strike Fighter program is supposed to be a model for future cooperative programs. Consequently, the DoD attempted to apply a new approach for cooperative research and development of the JSF. JSF is the DoD's most expensive aircraft and cooperative program with an estimated total cost of over \$200 Billion. The goal of the JSF program is to develop and to produce an affordable next-generation strike fighter weapon system and sustain it worldwide. The JSF program is expected to produce over 2,500 aircraft and replace the U.S. Air Force's F-16 and A-10, the U.S. Marine Corps' F/A-18-C/D and AV-8B, the British Navy's Sea Harrier, and to complement the U.S. Navy's F/A-18E/F. Currently, the program is expected to

produce 1,763 CTOL versions for the Air Force, 680 CV/STOVL versions for the Navy and Marine Corps, and 150 STOVL versions for the UK. Additionally, the Joint Strike Fighter Program expects to sell over 2,000 aircraft worldwide.

In order for the DoD to make the JSF Program a model for future acquisitions, the DoD created the program office earlier in the program than normal. This permitted the program office to concentrate on the following six areas for acquisition improvements.

1) Service Commonality: Competing contractors were encouraged early on to maximize commonality between the three variants for the Navy, Air Force, and Marine Corps. This would reduce costs by increasing economies of scale and would promote interoperability. The contractor's goal was to reach a level of 70 to 90 percent commonality in airframe, avionics, and engine.

2) Acquisition Cycle: As mentioned previously, the program office was established much earlier than usual for a weapons system. This allowed Integrated Product Teams (IPT's) composed of the major stakeholders to be formed earlier in the research and development phase. Additionally, the Concept Exploration and Program Definition Risk Reduction phases were combined into a single Concept Demonstration Phase. This permitted more time to conduct cost/benefit trade-off analysis, technology assessment, and requirements definition.

3) Requirements Determination Process: From 1995 to 1999, three joint requirements documents were developed with the assistance of the stakeholders. While developing the requirements documents, Cost As an Independent Variable

(CAIV) was stressed. Additionally, target prices were established for each version with \$28 million for the CTOL version, \$31 to 38 million for the carrier version and \$30 to 35 million for the STOVL version in FY94 dollars.

4) Technical Risk Reduction: In order to minimize risk, the program office identified areas of high risk and ways to reduce the risk. The program office was determined to use competitive hardware demonstration as a way to mitigate risk. For instance, the program office funded a \$110 million project to develop a multifunctional integrated radio frequency system (MIRFS). The MIRFS project was awarded to two contractors: Hughes Aircraft and Northrop-Grumman. These contractors were encouraged to develop lighter, lower-cost, active electronically-scanned arrays for fire control radars and demonstrate them.

5) Extended Design and Subsystem Competition: Competition was emphasized at the prime and subsystem levels throughout the Concept Definition and Design Research Phase. From 1994 to 1995, three prime contractor teams competed for the contract. The teams were Boeing, Lockheed Martin, and McDonnell Douglas/Northrop Grumman/British Aerospace. As previously discussed, the competition was then down-selected to Boeing and Lockheed-Martin. Additionally, since both potential prime contractors decided to use Pratt and Whitney F119 engines, the program office awarded an Alternate Engine Program with General Electric to design an alternate engine source.

6) International Participation: Since the program office was founded earlier than normal, significant international participation was sought during the beginning of the design phase. This was something that no U.S.

fighter developed since World War II had sought to do. The British, for instance, as full collaborative partners, were able to influence the design phase significantly.

3. Extent of International Participation

As previously mentioned, the JSF Program actively sought international participation early on in the life of the program, including requirement definition. The U.S. recognized the need for interoperability from lessons learned during Operations Desert Storm and Northern Watch. Additionally, the DoD perceived the ability to share costs and accessing best value, cutting-edge technology by pursuing and incorporating international partners. The following illustrates the extent and privileges of each international partner. Furthermore, the JSF organizational structure is presented in Figure X and the level of financial contributions in Figure Y.

a. Level I Partner:

- 1) United Kingdom
 - a) National Deputy: at the director level reports to the JSF Program Manager
 - b) JSF Program Office Staff: ten fully integrated staff, including the Deputy Director of the Systems Engineering IPT
 - c) Data Use Rights: includes use for the performance of project activities under SDD MOU's and future efforts by the United Kingdom (either collaboratively, nationally, or under U.S. Foreign Military Sales (FMS) arrangements) for the design, development, manufacture,

operation, and support of any JSF aircraft

- d) Benefits during Production: delivery priority based on level of SDD contributions; waiver of all non-recurring research and development costs; levies from sales to non-partners based on level of SDD contributions

b. Level II Partners:

1) Italy

- a) National Deputy: reports to the JSF International Director
- b) JSF Program Office Staff: five integrated staff, including a Logistics Manager on the Autonomic Logistics IPT
- c) Data Use Rights: Italian Ministry of Defense JSF purposes includes use for the performance of project activities under SDD MOU's and future efforts by the Italian Ministry of Defense (either collaboratively, nationally, or under U.S. Foreign Military Sales arrangements) for the design, development, manufacture, operation, and support of the JSF CTOL and STOVL variants
- d) Benefits during Production: delivery priority based on level of SDD contributions; waiver of all non-recurring research and development costs; levies from sales to non-partners based on level of SDD contributions

2) Netherlands

- a) National Deputy: reports to the JSF International Director
- b) JSF Program Office Staff: three integrated staff
- c) Data Use Rights - CTOL purposes includes use for the performance of project activities under SDD MOU's and future efforts by the Netherlands (either collaboratively, nationally, or under U.S. Foreign Military Sales arrangements) for the design, development, manufacture, operation, and support of the JSF CTOL and F-16 aircraft
- d) Benefits during Production: delivery priority based on level of SDD contributions; waiver of all non-recurring research and development costs; levies from sales to non-partners based on level of SDD contributions

c. Level III Partners:

- 1) Turkey, Australia, Canada, Denmark, and Norway
 - a) National Deputy: reports to the JSF International Director
 - b) JSF Program Office Staff: one integrated staff, who performs both national deputy duties and participates on the C4I IPT
 - c) Data Use Rights: includes use for the performance of project activities under SDD MOU's

Partner Country	Partner Level	Financial contributions (in millions)	Percentage of Total Costs	Projected Quantities	Percentage of Total Quantities
United Kingdom	Level I	\$2,056	6.2	150	4.7
Italy	Level II	1,028	3.1	131	4.1
Netherlands	Level II	800	2.4	85	2.7
Turkey	Level III	175	0.5	100	3.2
Australia	Level III	144	0.4	100	3.2
Norway	Level III	122	0.4	48	1.5
Denmark	Level III	110	0.3	48	1.5
Canada	Level III	100	0.3	60	1.9
Total Partners		\$4,535	13.7	722	22.8
United States		\$28,565	86.3	2,443	77.2

Table 4. JSF Cost Shares

Source: From GAO-03-1012T

B. PROGRAM ANALYSIS

Even though the JSF program office has taken significant steps to improve cooperative research and development and the acquisition process, the Joint Strike Fighter program still faces many challenges to meet the objectives of the ICR&D and to address the concerns of all the partners. The main issues facing the JSF Program are technology transfer, funding, industrial base, and return-on investment (ROI). Without actively addressing these areas, the JSF Program could see schedule slips, cost growth or partner withdrawal.

1. Technology Transfer

Technology transfer has caused significant problems for the JSF program. As of July 2003, Lockheed Martin has

already received over 400 waivers for technology transfer and is expected to receive more than 1,000 waivers prior to completing the program. This has caused a severe administrative burden for Lockheed Martin and the program office. The costs associated with administering the waiver program have reduced savings. Additionally, the time needed to receive waivers has reduced Lockheed Martin's ability to subcontract to foreign contractors. The failure to receive timely export waivers has negatively impacted subcontracting to foreign companies. This minimizes the program's ability to access foreign technology and to achieve best value procurements. Furthermore, several major subcontractors have avoided awarding work to international companies because of the extra administrative and cost burden. Failure to involve international companies has raised concerns by participating countries regarding the maintenance of their industrial base and continued support of the program.

As of July 2003, Lockheed Martin was only forecasting three months ahead for export authorization because most licensing resources were being used to manage time-critical authorizations. Lockheed Martin has failed to complete a long-term industrial participation plan that would identify areas of future competition and contracts. A long-term plan would minimize disruptions by permitting international companies to receive export licenses early on.

As mentioned above, failure of involving international companies could result in cost growth and lack of international support. In order to mitigate these

concerns, Lockheed Martin has implemented several strategies. A few of these strategies are as follows:

- Added additional resources to handle the large volume of waivers requests.

- Received a global project authorization (GPA). The GPA provides an "umbrella" export authorization for over 200 partner suppliers for transfer of certain technology. The GPA is expected to reduce the authorization process to five business days.

- Appointed a JSF export compliance officers.

2. Funding

Continued funding support by international participants with respect to cost shares and affordability could severely impact cost growth and future sales. JSF has already experienced significant cost growth. Consequently, cost shares have become distorted over the program's life. As discussed in Chapter II of this project, percentages are established during the programs inception regarding funding contributions necessary for the various partnership levels. However, these funding objectives are based upon target costs and will not likely represent real costs. JSF has gone from estimates of \$22.1 billion to \$33.2 billion for research and development. Furthermore, estimates for the CTOL version went from \$28 million to \$31 million on November 26, 2000. International participants are not required or expected to contribute additional funding caused by cost increases resulting from U.S.-initiated scope changes. For instance, the UK has contributed 6.2 percent of the program funding as illustrated in Table 4. As a full partner, the UK

originally contributed ten percent. The U.S. is forced to fund the additional requirements. Partners could attempt to receive additional funds but they are required to go through normal procedures. Increased funding, therefore, is unlikely if the partner want to maintain participation. Consequently, the DoD has reduced order quantities for the aircraft to pay the increases. The DoD could attempt to recoup the additional costs by reducing levies for partners on future sales.

Affordability also plays a crucial role for continued funding by partners. If JSF becomes too expensive, many partners may be forced to withdraw from the program and seek other options. This even holds true for the DoD. In a report to Congress, the Congressional Budget Office (CBO) conducted a study of alternatives to JSF. CBO evaluated several alternatives to full funding of the JSF for the DoD. The first option assumed procuring only the Air Force version and increasing procurement of the F/A-18E/F for the Navy and Marine Corps. CBO estimated a savings of \$2.5 billion. Another option was purchasing only the Marine Corps version. CBO estimated a cost savings of \$4.5 billion. The final option was to purchase only 40 percent of the planned Joint Strike Fighters. CBO estimated a saving of \$5.6 billion by using this option. If Congress were to fail to fund JSF fully, unit costs would rise and be passed on to all partners. In fact, JSF is about to declare a Nunn-McCurdy Breach.

3. Industrial Base

Partners expect the use and involvement of foreign industrial bases. Failure to include domestic contractors could jeopardize future the partner's future program

participation. Additionally, the partners have expressed concern about having organic logistics capabilities for continued support that are only feasible with a robust industrial base. In order to maximize cost savings, the JSF program has attempted to apply best value procurement for subcontracts similar to commercial practices. Instead of awarding subcontracts on the basis of contribution share ratios of international partners, the program is attempting to apply best value while using the Cost as an Independent Variable (CAIV) concept. Awarding contracts completely on the basis of best value is unlikely. As the program office admits, some contracts will likely be awarded to foreign contractors in order to maintain the good will of the partner country. This will reduce savings associated with leveraging the best value technology of participating nations, which is one of the goals of cooperative research and development.

In an attempt to mitigate this concern and motivate Lockheed Martin to actively pursue foreign companies for subcontracting, the award fee structure permits the JSF Program office to identify and establish focus criteria for each period. The criteria included judging Lockheed Martin's ability to provide partners with regular insight into subcontracting opportunities, encouraging major subcontractors to consider foreign companies on a competitive basis, and acquiring the needed export licenses in a timely manner to support foreign competition.

4. Return-On-Investment (ROI)

Partners expect to receive a considerable ROI by investing early on in the JSF Program. Part of the ROI refers to receipt of major subcontracting work for their

industrial bases as described above. Partners expect domestic companies to receive an amount of work near the value of their investment in the program. Also, technology access to improve domestic capabilities falls under ROI's expectations. However, the most significant driver of ROI corresponds to the anticipated financial gains associated with levies collected on future Foreign Military Sales of aircraft to non-partner nations. The DoD reported partners could earn between \$5 and \$40 of revenue in return for each dollar contributed to the program. Failure to meet these expectations could jeopardize the future support and participation of the partners.

C. CURRENT STATUS

The Joint Strike Fighter Program is scheduled to begin Low-Rate Initial Production in 2006 with 22 test aircraft. Fourteen will be flight test aircraft and eight will be ground test aircraft. Full-Rate Production is scheduled to begin in 2008 with Initial Operating Capability in 2010.

VII. CONCLUSIONS

A. INTRODUCTION

Among the common challenges encountered by the three programs (MLRS, MEADS, and JSF), there is a factor that appears to be key for success in any ICR&D program. This factor is stability. Stability refers to a program's susceptibility to disruptions in funding, schedule, requirements, and political and other support. Stability must always be present at any stage or in any process of an ICR&D program. A lack of stability leads to the demise of the program.

The programs discussed in this project frequently lacked stability in major areas such as funding, technology transfer, requirements determination, management approach, and government commitment. Greater issues of stability such as U.S. or European political or economical stability or continuity are beyond the scope of this project, but will be briefly mentioned where necessary to support the findings. Funding, technology transfer, and requirements determination are the key elements for stability and will be discussed in further detail.

B. FUNDING

The high technology and complexity involved in MLRS, MEADS, and JSF imply a very expensive defense system that most countries cannot fund on their own. As such, these programs, which started as national programs, evolved into multi-national ones in order to capture needed funding. That meant that these programs suffered a lack of committed funding from the start. Funding contributions determine the country's category and its associated rights in the

ICR&D program. Restrictions inherent with categorization by funding levels create initial challenges for the program. For instance, those countries providing at least ten percent of funding, participate in requirements development and receive a waiver for all non-recurring research and development costs.

Additionally, countries can either contribute funding for the production phase or drop out of the program upon completion of the cooperative research and development phase. Countries are also permitted to increase or lower their contribution levels. Consequently, cost burdens can shift at this stage and funding can once again become an issue for the remaining countries.

For instance, the MLRS SADARM program was terminated because of a lack of funding and U.S. withdrawal from the MLRS/TGW program (to commit to the BAT system) precluded that program from entering production. MEADS was categorized as a follow-on system and consequently lacked the necessary long-term dedicated funding early on. MEADS' low priority for the U.S. almost cancelled the program.

European countries usually commit funding for the entire life of the program, which avoids having to continually justify its existence to defense decision-making authorities. On the other hand, the U.S. normally commits funds annually to a program and must constantly re-justify the program to numerous defense decision-making authorities, especially Congress.

In addition, new administrations may require time to establish funding priorities and may not agree with the funding priorities of past administrations. As such, separate national political processes reduce program

stability, especially in the U.S. because a program must repeatedly regain political support for funding.

1. Cost Shares

ICR&D allows participating nations to share the burden of weapon-system development. Cost shares define each participating nation's cooperative status and privileges. Information disclosure gained during the program is normally tied to cost shares. A multi-national program will likely encounter multiple problems in tracking and managing cost shares, exchange rate fluctuations, and inflation, as demonstrated with MLRS, MEADS, and JSF.

Cost shares distribution dictate supremacy of one nation over the others in the ICR&D effort, which then tends to accommodate that nation's interests and requirements more closely. All programs, consequently, were directed by the country with the highest cost share, independent of other factors that may be more important to the program's success. Newer ICR&D programs, instead of awarding subcontracts based on contribution share ratios of international partners, are attempting to apply best value while using the Cost As an Independent Variable (CAIV) concept.

Furthermore, continued funding support by international participants regarding cost shares and affordability could severely increase costs and future sales. For instance, the JSF has already experienced significant growth in costs. With increased costs, each country must fund its equivalent portion according to its cost share. Increased costs could lead countries to drop out of the programs. However, international participants are not required or expected to contribute additional

funding caused by cost increases resulting from U.S.-initiated scope changes.

In addition, if the JSF becomes too expensive, many partners may be forced to withdraw from the program and seek other options. As noted, even ICR&D programs suffer from the cost overruns experienced by stand-alone defense acquisition programs.

2. Budgeting

The end of the Cold War represented an opportunity for governments in the North Atlantic Treaty Organization (NATO) to decrease their defense budgets. Decreasing budgets resulted in a steady decline in government research and development expenditures relative to industry R&D. Increasing ICR&D efforts in the 1990's was required in order to share cost burdens associated with research and development.

JSF, the newest program, has applied recent planning, programming, and budgeting initiatives. For instance, while developing the requirements documents, Cost As an Independent Variable (CAIV) was stressed. Additionally, target prices were established for each version of the aircraft. However, restrictions existent at the budgeting level do not allow pursuing more U.S.-European defense cooperative programs on major weapons systems. For instance, European procurement budgets are small compared to the U.S. budget, and the potential that U.S. support for a program may change with each annual budget review, may cause concerns for European governments.

C. TECHNOLOGY TRANSFER

ICR&D's goal is to provide the most economical and advanced weapon systems, while sharing risk and technological expertise. However, military weapons have become so dependent upon technology that large quantities are not only difficult to produce in a short period, but expeditious startup and production are more difficult. Thus, warfare depends now on a few precise high-technology maintainable weapons rather than on the mass-produced expendable weapons of the past. In today's world, technology leads to any military's competitive advantage. Consequently, countries are reluctant to share or transfer any technology that represents superiority over another country's military. This reluctance has impeded, to some extent, progress in the ICR&D efforts, as demonstrated in JSF and MEADS.

The three ICR&D programs analyzed suffered, and still suffer, from strict arms export controls imposed by the U.S. Government, as well as the U.S. policies and procedures for releasing sensitive national security-related information to foreign governments and companies. Admittedly, controls are necessary to provide protection against loss of technology to unauthorized users. However, export controls undermine defense trade between the U.S. and Europe. Critical technologies for the programs' success were not disclosed in a timely manner leading to both resentment among participating countries and schedule delays. For any international cooperative effort to be truly interoperable and successful, the DoD must provide information that it has traditionally been reluctant to share.

1. Industrial Base

Industrial base restructuring and consolidation has increased in recent years since most nations can no longer afford to develop and to procure enough defense items from their own domestic companies and sources. For instance, the European Defense Industry is attempting to consolidate and restructure through national and cross-border mergers, acquisitions, joint ventures, and consortia. However, the size and consolidation of the U.S. defense industrial base overpowers and poses a challenge to any initiative or effort in the smaller and fragmented European defense industry. This creates a barrier for more equally distributed and funded ICR&D programs. Thus, European nations are currently pursuing several initiatives to integrate their defense markets first and then challenge the U.S. defense industry in the arms marketplace (e.g. Eurofighter vs. JSF, SAMP-T vs. MEADS).

Even with the differences in size, scope, and structure between the U.S. and European defense industrial bases, ICR&D provides a method to maintain military technological superiority on both sides of the Atlantic Ocean, while satisfying national political, economical, social, and industrial goals.

Although both the U.S. and the European defense industry are restructuring in response to budget cuts, shrinking export sales, and rapid technological advances (many of them driven by commercial applications), the U.S. defense industry is mainly in private hands and market-based while the European defense industry remains mainly controlled and managed by their governments.

2. Work Shares

The complexity and difficulty of managing a successful international program significantly increases with each additional partner. The increased complexity of decision-making with partners places stress on any ICR&D program. Consequently, there is a schedule impact due to the accountability and management of work shares by all participants. Furthermore, work shares are related to cost shares, increasing the difficulty in managing tasks. All programs studied seemed to be less efficient in terms of technical performance, program management, decision-making, and administrative issues due to the distribution of work shares. A program will likely encounter more problems in tracking and managing work shares if it is multi-national.

National politics drive conflicting desires of each participant to minimize expenditures while maximizing the local benefit. However, the desire to maximize local investment greatly complicates management since balancing workloads must be accomplished. Consequently, not only must the workload be balanced, but also each partner must see the work as meaningful.

3. Policy

The United States has made significant policy changes since the early 1980s in order to enhance ICR&D. The Quayle and Nunn-Roth-Warner Amendments, the Cooperative Opportunities Document, the creation of the Armaments Cooperation Steering Committee (ACSC), and the 1997 Cohen Memorandum on DoD International Armaments Cooperation Policy, have all provided a sound foundation to expand ICR&D. However, restrictions on foreign investment in the U.S. defense market, industrial security regulations, Arms

export restrictions, and restrictive legislation have colluded to prevent complete access to the U.S. market for European defense goods. Furthermore, political changes at the Federal Government Administration level and U.S. foreign policy after the tragic events of September 11th, have, to an extent, impeded further progress in ICR&D efforts. Additionally, it is difficult to maintain continual oversight of DoD's armaments cooperative activities and ensure these activities receive the proper visibility and conform to U.S. national security policy.

At the same time, there is pressure in Europe to develop a unified European armament procurement policy. However, national sovereignty issues and complex ownership structures are preventing European consolidation to the extent needed to be competitive. Consequently, cooperative programs between the United States and the European nations are struggling for sustainability and stability amidst constant policy changes mainly due to the rapidly evolving world events and threats.

Essentially, the formation of a more unified European defense market may be crucial to the survival of European defense industries as well as to their country's ability to maintain an independent foreign and national security policy. Consequently, the survival or creation of cooperative programs will depend more upon each country's policy and position regarding their Armed Forces and industrial base, and their need to stay independent in these matters.

Either way, both the U.S. and the European nations discussed in this project will remain committed to a "common and shared" national defense procurement policy:

first, buy technically-sophisticated equipment from your own sources, then, pursue cooperative solutions, and finally, import a non-American or non-European item.

D. REQUIREMENTS DETERMINATION

Harmonizing requirements for an ICR&D program is one of the most important activities and it is not easy. Nations have different interests and priorities. Threat, date needed, functions to be performed, characteristics, and required operational environments must be harmonized. National laws and regulations may conflict. Additionally, understanding the needs of a partner is essential to making needed compromises. The three programs studied all faced challenges determining requirements.

A capability not needed by one nation will be opposed by that nation in an effort to hold down costs. Conversely, a capability perceived as important by that nation will be vigorously promoted. One manner JSF dealt with the issue was the creation of national and/or service variants built around a common core capability. However, the U.S. and Europe will probably continue to maintain similar equipment in the long term. This commonality of equipment will create regular opportunities to cooperate on acquisition projects.

A cooperative requirements phase is absolutely necessary before beginning development or signing an MOU. Additionally, solid Service(s) Mission Needs Statements should be established before negotiating cooperative requirements. The programs studied generally did not have well-defined requirements. Consequently, invaluable time was spent determining the exact requirements for each

participating country. For instance, MLRS started with only the most general agreement on the need for a tank-killing submunition and a broad technical approach. Planning must allow enough time for MOU negotiations, as well as international program development. Mutually acceptable, fully harmonized and rationalized, functional performance specifications should be set versus a target equipment design.

In determining requirements, operational and acquisition perspectives must be considered in order to achieve a program that adequately satisfies common needs, but at the same time can be a "doable." Some of the overall cost savings of cooperative programs go toward delivery of certain requirements that particular nations do not need. Understanding the cost impact of specific requirements often greatly facilitates resolution of differences.

1. Assessment of Threats

With the end of the Cold War, countries started dealing with evolving and differing threats. Consequently, weapons programs needed changes to their initial requirements. The requirement changes affected all three programs studied. For instance, changes in the MLRS/TGW program to address the new threats encountered by each participating country, negatively affected cost, schedule, and technical risk. In MEADS, incorporating the Lockheed Martin PAC-3 missile into the system met U.S. requirements, but not German and Italian needs. Consequently, these governments have called for a study on bringing a second missile into the program that will probably cause schedule delays and increase costs.

2. Partners

The number of partners has a significant effect on the performance of ICR&D programs. Each additional partner increases the risks due to the complexity and difficulty involved. Having many partners increased the complexity of decision-making in all three programs. The diverse acquisition and political procedures of each partner placed stress on the program managers and eventually impacted program schedules.

Additionally, U.S. allies are reluctant to join trans-Atlantic programs where European countries are junior partners, fearing that the U.S. will ignore their interests. However, if both sides share the project "equally" or when it is in their interest, such as programs enabling European nations to benefit from access to U.S. advanced technology, then European allies favor cooperation. Most European countries partner with the U.S. when the latter occurs, as noted with MEADS and JSF.

3. Culture

In any ICR&D program, every participating country has a unique way of conducting business. The understanding and acceptance of another country's culture is extraordinarily useful when working in international programs, and improves communications and processes. Cultural differences between the U.S. and NATO allies have influenced ICR&D programs. Program Managers gradually learned that if all the staff was located in an international project office, then a greater team culture can be established and help resolve many of the language barriers, nationalistic issues, and decision-making obstacles that they experienced.

Sharing an office also resolves administrative and geographical issues such as the use of paper instead of e-mails, and the time dedicated to telephone discussions due to the difference in time zones. Another cultural issue, for instance, was the time and seasons devoted for holidays and vacations.

As a program advances, new players enter. Each will bring unique personal and cultural backgrounds, experience, values, assumptions, sense of time, and procedures. As noted, differing national cultures and norms of behavior affect day-to-day program operations, especially in ICR&D. The three programs studied were no exceptions to this. Cultural differences are not only challenges for each individual, but also for each nation's team.

E. CONCLUSION

With International Cooperative Research and Development (ICR&D), the DoD and a foreign defense ministry, by written agreement, jointly manage a RDT&E and/or production effort to satisfy a common requirement by sharing work, technology, and costs. The purpose is to improve current and future defense posture, enhance the industrial base, avoid duplicate R&D, reduce RDT&E costs to each party improving standardization and interoperability by sharing information and cost burden.

In light of the increasing role that international coalitions have had in recent world events, ICR&D presents a viable alternative to traditional Foreign Military Sales for interoperability improvements. ICR&D has become the preferred choice for weapon-system development as illustrated by the large volumes of studies and literature found and researched.

Every program managed so far under the ICR&D approach has faced multiple and recurrent challenges. Although the process is improving, the efforts are still hindered by some of the same problems encountered in ICR&D's early programs dating back to the late 1970's.

However, as U.S. and Allied Armed Forces are downsized, budgets reduced, coalition operations increased, and the defense industrial base consolidated and restructured, ICR&D should continue as a way to increase the effectiveness and efficiency of the U.S. and Allied Armed Forces, plus their associated defense industries. The United States, France, Germany, and the United Kingdom will probably compromise on a mutually acceptable solution to any issue in the MLRS, MEADS, or JSF programs because of their shared common interest in preserving a strong NATO to ensure continued European stability.

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VIII. RECOMMENDATIONS

A. RECOMMENDATIONS

The analysis and conclusions established in the previous chapters lead to the following recommendations in order to improve program stability for ICR&D and to reduce risk. The recommendations are presented as either general in nature or specific to the areas discussed in the conclusions chapter.

1. General Recommendations

a. Ensure that Lessons Learned so far by the United States and the European nations are considered and applied when entering into any new cooperative program. These lessons include careful consideration of all available program information before agreeing to develop a weapon system jointly and assurance that funds will be available for program execution.

b. Conduct a cost-benefit analysis prior to program inception to determine the appropriate number of partners. This mitigates problems regarding program management, technology transfer, and administrative and financial oversight. The cost-benefit analysis facilitates making a managerial decision regarding the appropriate number of partners. However, experience indicates that ICR&D programs with two to three Level I partners are generally easier to manage and less costly.

c. Emphasize commonality since partners often have different requirements. Commonality facilitates reduced cost per article while meeting the needs of each partner. Furthermore, commonality mitigates schedule risk

associated with trying to meet all requirements in one version.

2. Funding

a. Establish approximately equal cost shares for the participating countries when conducting ICR&D programs, if possible. This leads to satisfying requirements and interests equally for all parties involved. Other cost share arrangements (i.e. MLRS' 40/20/20/20 or MEADS' 60/25/15) were not very successful. For instance, the best possible cost arrangements are 50/50 or 25/25/25/25 share ratio. If equal cost shares are not possible, minimize the number of Level I partners. This prevents having many low-contributing partners that affect the generation of requirements. Therefore, schedule risk and cost growth are minimized.

b. Conduct and emphasize cost analysis during program inception. This will improve cost sharing and reduce risk. It will also mitigate the risk of international participants incurring financial difficulties due to cost growth.

c. Continue to emphasize Cost As an Independent Variable (CAIV) from the beginning. Implementation of CAIV in the JSF program has proved to be valuable for keeping costs under control when compared to other similar ICR&D programs. Establishing target goals for weapon systems costs permit the contractor to improvise design and save money. Additionally, CAIV enables cost/benefit tradeoff analyses.

d. Conduct a cost-benefit study regarding utilizing multi-year funding for ICR&D programs on an exception basis. Currently, multi-year funding is only

available from Congress for procurement. Admittedly, using multi-year funding for ICR&D would meet resistance. However, since multi-year funding improves funding stability and reduces the risk of program withdrawal, it should be investigated as an option for the future. Furthermore, multi-year funding eases the partners' concerns regarding program priority and commitment by the U.S.

3. Technology Transfer

a. Conduct ICR&D with the goal of modular designs in order to lesson technology transfer. Modular designs permit placing only appropriate technology in exported products as listed in the AECA. If designed from the beginning with this concept in mind, fewer waivers are required and costs associated with waiver approval delays are reduced. Additionally, modular designs facilitate product improvements to weapons systems as technology matures. New technology can be inserted into the platform with minimum cost and time. A final benefit of modular design occurs in subcontracting and competition. By reducing waivers, prime contractors have more time to compete subcontracts to international contractors. There is a larger cost savings associated with exploiting international industrial bases. This also reduces the possibility of schedule slips and cost growth.

b. Conduct a thorough review of the Arms Exports Control Act (AECA). The review will permit updating regulations to reflect current world geopolitical and market conditions more accurately. Extra care must be exercised during the review to find ways to streamline the ICR&D process.

c. Receive AECA class waivers early in the program. This reduces the paperwork necessary to execute the program and facilitates the use of competition for systems and subsystems.

4. Requirements Determination

a. Choose partners that have similar requirements. Having partners with similar needs minimizes the number of trade-offs required for the program. This mitigates schedule risk and reduces conflicts associated with requirements determination. Furthermore, cost growth is reduced since partners require less country specific weapon systems.

b. Establish the program office earlier in the lifecycle and collocate all members of the team. Establishing the program office early facilitates stabilizing the design and requirements quickly. This mitigates schedule risk and allows more time for tradeoffs. Furthermore, this reduces cost growth from changing requirements. Additionally, having all team members in one location improves teaming and mitigates cultural issues associated with international programs.

B. AREAS FOR FURTHER RESEARCH

The following recommendations are areas for further research in International Cooperative Research and Development:

1. Every individual program considered in this project offers further research opportunities. As such, further research projects can be conducted and are recommended for the Multiple Launch Rocket System (MLRS), Medium Extended Air Defense System (MEADS), and Joint Strike Fighter (JSF) ICR&D programs studied.

2. Every issue considered as necessary for the success of an ICR&D program is also a further research opportunity. As such, every issue by itself leads to more extensive and exhaustive research. For instance, Funding, Technology Transfer, and Requirements Determination in ICR&D programs should be further researched, developed, and analyzed beyond the scope presented in this MBA project. Other issues available for consideration as ICR&D MBA projects could include, but are not limited to, Industrial Base, National Security Policy, Returns on Investments, Partnerships, Management Approach, Government Commitment, Cost and Work Shares, Political Environment, and Economic Conditions.

3. Conduct further research on International Cooperative Research and Development (ICR&D) to determine cost savings (if any) through cost sharing and economies of scale in jointly managed research and development, production, and logistics support programs. Programs suggested for cost savings research could include the ones analyzed in this project: JSF, MEADS, and MLRS.

4. Conduct further research on the influence of the U.S. Arms Export Control Act in technology transfer issues regarding ICR&D programs. This study could provide a new approach to armaments cooperation that would ease technology sharing and equitably divide the program's development and production work share. The impact of current European technology transfer policies should also be studied.

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